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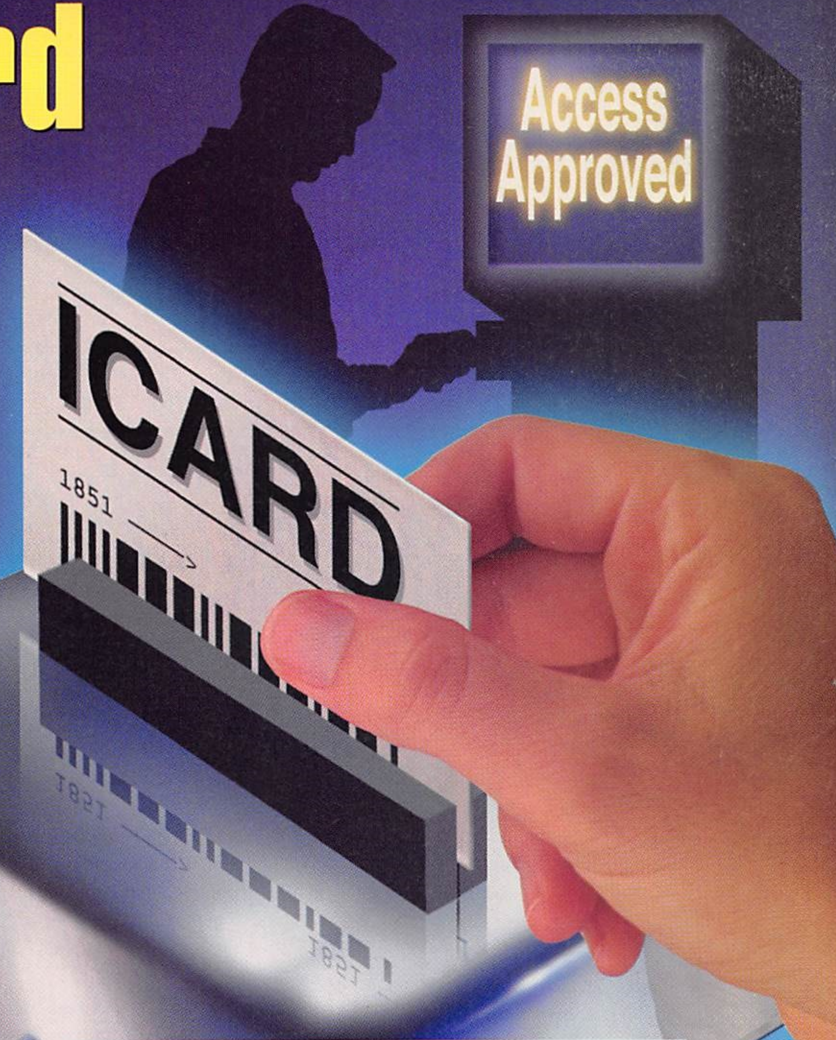


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## TECHNOLOGY





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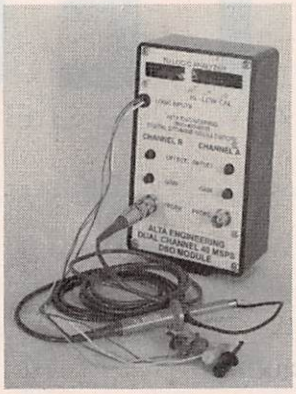

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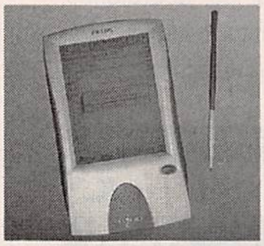




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# EDITORIAL

## T-DAY 1998

The government tells us that the economy is in great shape and unemployment is down. That might be true, but it does not change the fact that to get ahead and stay ahead in your career, you need an advantage over your competition.

Nowhere is that more true than in the electronics-servicing profession. For an electronics technician, the challenge is twofold. First, he or she must deal with the types of ups and downs that are common to any profession, especially in these days when companies ruthlessly look after their bottom line. But second, they must make sure that they do not become obsolete.

The problem is that electronics technology is constantly evolving. What was state-of-the-art last year is mundane and common this year. What was state-of-the-art five or ten years ago is now an antique.

So, then, how does an electronics technician stay current? Even more important, how does a technician demonstrate to his present or potential employer that he or she is both up-to-date and competent?

That's where the Certified Electronics Technician (CET) program comes in. Technicians who have earned the CET designation have demonstrated to their employers and colleagues that they have the knowledge needed to deal with today's technologies, and the skills to do so successfully. They have also demonstrated that they have the dedication and desire needed to succeed in their chosen profession.

To honor those professionals who have earned the CET designation, and to encourage others to join their ranks, the International Society of Certified Electronics Technicians (ISCET) has set aside Tuesday, April 21, 1998 as "T-Day," and the week of April 21 through April 25 as "T-Week". As part of the celebration, ISCET has established a network of Volunteer Examiners to help qualified electronics technicians earn the CET designation. To learn more about that opportunity, the CET program, and ISCET, please turn to the story on page 54 or visit ISCET's home page at www.iscet.org. Both you and your career will be glad you did.

Carl Laron

Carl Laron
Editor

# LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

## Capacitance-Substitution Box Error

There is an error in the "Audio Update" column in the February 1998 issue of **Electronics Now**. In the schematic for the capacitance-substitution box, only the first row of capacitors connects to one of the binding posts. The PCB layout is correct, and so is the parts-placement diagram. But if you trace through the schematic, you'll see that from the second row on, the capacitors do not connect to both binding posts when switched.

REN TESCHER
via e-mail

## If They Build It, Will They Come?

Your editorial in March 1998 raised serious questions. One might also ask, "If a DTV commercial airs, and no one has sets capable of receiving it, can you bill for it?" The answer is clearly NO, since advertising cost is based upon viewers' share data. No viewers means no billing. Will stations convert, with no initial revenue stream, or turn in their licenses for the free use of spectrum? It seems obvious that both cable and over-the-air channels must subsidize their cost for equipment for DTV transmission with real revenue from NTSC standard advertising. The networks had to install new gear when color TV was introduced, but the pie was divided only three ways back then in the late 1950s. As cable multiplied the number of channels, the pie became decimated, raising the investment/return number to perilous levels. The FCC has enabled the subsidization by allowing a flexible mix of broadcasting, so what's the fuss all about? The new sets will have dual-standard performance, and as aging sets are replaced by new ones, we will eventually all have DTV sets.

For me, a professional in the industry who gets to play with the latest toys long before I can afford them at home, the real question is whether we really need High Definition TV. After living with three different DVD players and Laserdisc players, and having seen many HDTV demonstrations, I have personally concluded that what I have is good enough—for now. I bought far more surround sound equipment in the last year than TVs. The next TV I buy must be priced under $1600, offer just as tall a picture as my $800 32-inch set (forget the screen's diagonal measurement, guys), have DTV input capability, and make watching NTSC-format DVDs, LDs, and VHS tape even better. It's simple, really. Are you marketing guys listening?

MICHAEL NEIDICH
Santa Clara, CA

## Web Compliment

I just wanted to take a second to compliment you and your entire staff on one of the best Web-site designs I have ever seen. It was clear, concise, and to the point. While it was rather graphics rich, the pages loaded quickly, and I was able to find exactly what I needed (the address change form).

It's great to see someone using the media effectively and creatively. Keep up the good work.

TIM QUINN
via e-mail

## A Resource Omitted

I read the item on handheld data acquisition in Don Lancaster's "Tech Musings" column (**Electronics Now**, January 1998). The world's leader in the industry was conspicuously missing from the list of resources. Symbol Technology is the only company that designs, develops, manufactures, and markets its products. Our revenues exceed $700 million, and we are growing at a rate of 20% per year. Interestingly enough, one of our competitors listed (Intemec in Washington) is also a customer. They purchase our scan engines for their products. Many of those listed who are not competitors are customers. If any of your readers are interested in finding out more about us, they can visit our Web site: www.symbol. com.

MARGARETT M. EISENBERG
Senior Human Resources Representative
Symbol Technologies, Inc.
Holtsville, NY

EN

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Due to the volume of mail we receive, not all letters can be answered personally. All letters are subject to editing for clarity and length.

# Q & A

READERS' QUESTIONS, EDITORS' ANSWERS

## Electronic Dice

**Q** *I want to build an electronic set of dice using LEDs in the traditional arrangement. The purpose of using LEDs instead of a numeric display is to teach children how to count and add dots. I want to be able to disable one of the two dice for some games. I want to build this project as a Christmas present for my grandchildren. — C. J. G., Sebring, FL*

**A** Unfortunately, our backlog, and the fact that this column is written four months before publication, didn't allow us to get to this project in time for Christmas. But perhaps the children could enjoy it during summer vacation.

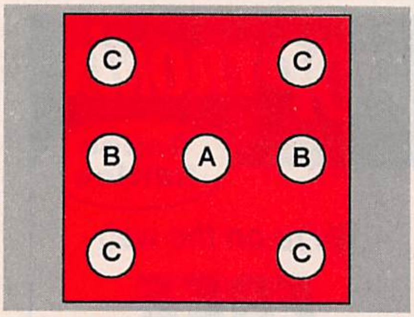


FIG. 1—THE LEDs in our electronic dice are switched in three groups: A, B, and C. Each whole group is either on or off.

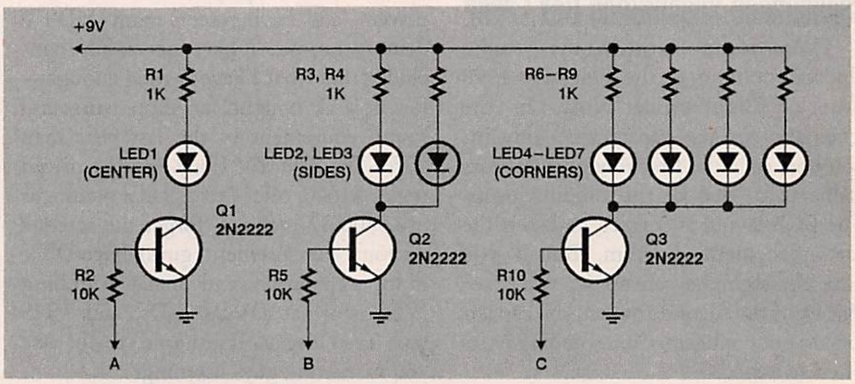


FIG. 2—BECAUSE THE LEDs are driven in three groups, this LED driver circuit needs only three inputs.

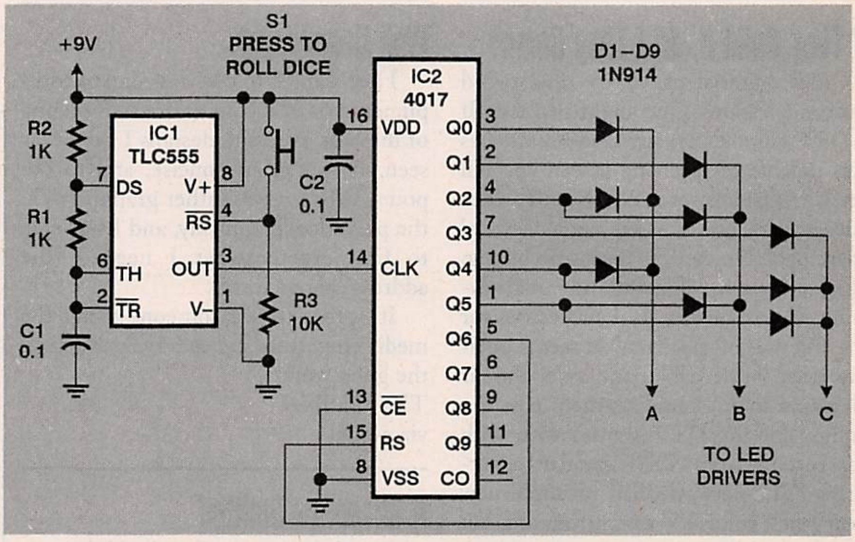


FIG. 3—TO ROLL THE DICE, press switch S1. When the oscillator stops, one of the outputs of the 4017 is left high, determining the dice display.

As you can see from Fig. 1, the seven LEDs that serve as spots on each die can be switched in three groups, which we'll call A, B, and C. For example, to display 5, you'd turn on groups A and C. Accordingly, the LED drivers, shown in Fig. 2, only need three input signals. Each signal tells whether to illuminate each set of LEDs.

To roll the dice, use the oscillator/counter circuit in Fig. 3. When the button is pressed, the oscillator runs at 5 kHz and the 4017 decade counter activates its outputs, one at a time, too fast for the human user to see, resetting itself whenever the count reaches 7 (output Q6). When the button is released, the oscillator stops, one of the outputs is held high, and the diodes direct the signal to the appropriate combination of A, B, and C outputs, which are connected to the LED drivers.

To build two dice, you can connect one oscillator to two 4017s. To deactivate one die, cut off power to its LED drivers. Leave both 4017s powered up because CMOS chips can be damaged if their inputs are driven while supply voltage is absent.

## Weather Satellites

**Q** *It just occurred to me that the PIC microcontroller chips would be perfect for collecting weather satellite data streams and converting the tone bursts into binary code. Unfortunately, I haven't been able to locate a source for what data streams are transmitted. — N., Waco, TX*

**A** A more powerful microprocessor might be even better for this—in fact, most satellite experimenters use their

PCs for ease of programming. To learn more about weather satellites, and to see some applicable 8088 assembly code, see the *Weather Satellite Handbook* published by the American Radio Relay League (Newington, CT 06111; Web: www.arrl.org).

## Hacking VCR Timers

**Q** *The electronic timers built into VCRs are handy since they cover long periods (up to a year) and provide for multiple on-off cycles. I have acquired several defunct VCRs and am reusing their timers for other purposes. I've had no trouble finding a switched 12-volt circuit in the VCR and connecting a relay there. To get the timer to work, I had to short out the "cassette-in" switch and cover the end-of-tape detector with black electrical tape. But how can I keep the take-up reel's motion sensor from shutting down the VCR after a few seconds? — E. R. B., Jamaica, NY*

**A** Reusing VCR timers is a worthwhile idea. However, as you've discovered, VCRs include many protective mechanisms to keep them from eating tapes, and you have to do several things to fool the timer into thinking it's controlling a properly working VCR.

The take-up reel motion detector normally uses an LED whose light is reflected into a photocell by a disk with alternating black and white sectors, creating a pulsing signal. When the pulses stop, the control circuit infers that the tape must not be moving.

You might drive the LED from a flasher circuit (or substitute a flashing LED) and use a stationary white reflector. Or you might feed a low-frequency squarewave (from a 555 or the like) directly into the control chip in place of the signal from the photocell. If you take the latter approach, not knowing the electrical requirements, you should probably start by feeding the signal through a large resistance (such as 1 megohm) and decrease the resistance until you get a response.

## Color Subcarrier Frequency

**Q** *I have an NTSC laserdisc player that I would like to use with my JVC television, which supports PAL, SECAM, and NTSC-4.43 formats. Unfortunately the laserdisc player uses the American standard 3.58-MHz subcarrier frequency, rather than 4.43 MHz, and I can only see the picture in black and white. Is there any circuit I can build to convert the 3.58-MHz signal to 4.43 MHz so I can get color? — N. P., Samambula, Suva, Fiji*

**A** It doesn't sound simple because what needs converting is a small part of a very complex signal, and it's not a fixed 3.58-MHz oscillation—it's a subcarrier with color information phase-modulated onto it. The conversion circuit would have to demodulate the composite video signal completely into luminance, color, and sound, and modulate it again. This would require much of the circuitry of a television set.

PAL, SECAM, and NTSC are of course the three major systems of color TV modulation (British, French, and American respectively). The NTSC standard specifies a 3.58-MHz subcarrier, but you indicate that your TV uses a 4.43-MHz subcarrier, which is standard for PAL and SECAM. The bottom line is that your TV supports NTSC video only partially.

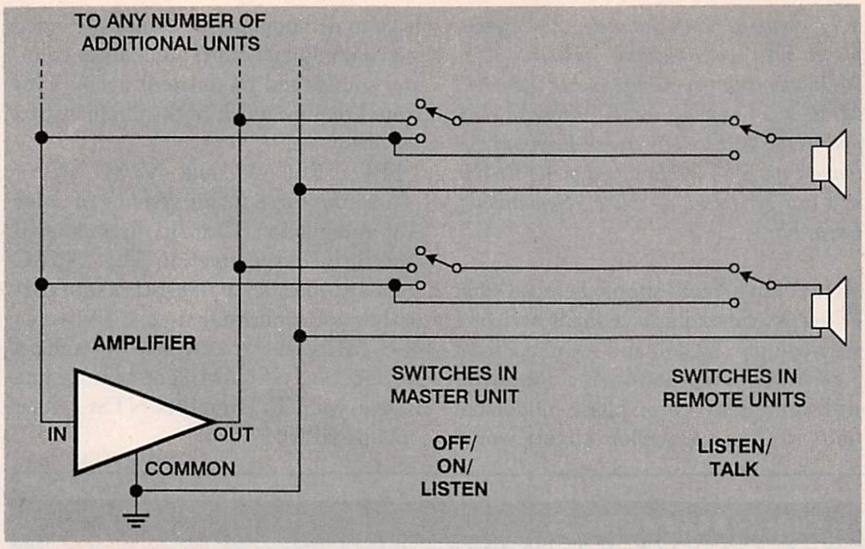


**FIG. 4**—HOW TO WIRE AN INTERCOM. The master can set any remote unit to off (silence), on (to feed it audio from whomever is talking), or listen (to listen continuously to the remote).

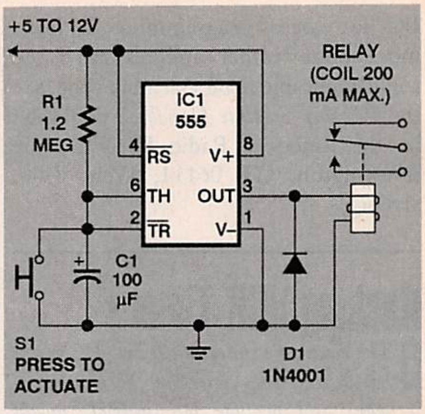


**FIG. 5**—WHEN THE PUSHBUTTON SWITCH (S1) is closed, the relay closes for two minutes, then opens. Do not use the CMOS versions of the 555 chip (7555, TLC555, etc.) for IC1.

## Intercom Wiring

**Q** *My question is about the intercom you describe in the February 1997 issue (pg. 14). It works very well with two stations, but how can I hook up more than that? — D. R., St.-Augustin-de-Desmaures, Quebec, Canada*

**A** Note that in the original diagram, the two remote units are connected in parallel. That is, each unit is connected to the same three places in the amplifier circuit. You can connect many more units in parallel with them in the same way.

Figure 4 shows a more sophisticated way to wire an intercom so that the master unit can turn any of the remote units on or off, or place it in continuous "listen" mode (for baby monitoring and the like). When any unit talks, it is heard on all the units that are switched on, not just the master.

The speaker in the master unit is wired just like a remote unit except that it does not need an "on/off/listen" switch; wire it to be "on" all the time.

## Two Minutes of Power

**Q** *I need a 555 timer circuit that will activate a relay for two minutes when a pushbutton is pressed, which means the output will stay high for two minutes, then go low and stay low, and go high for two minutes again when the button is pressed again. The circuit may be similar to "Delayed Power-On" published in November, 1997, pg. 8, but I tried to change it without any luck. — C. L., Pittsburg, KS*

**A** The circuit is indeed very similar, as shown in Fig. 5. (See also "Five Minutes of Power," which we discussed on pg. 12 in the January 1997 installment of this column.)

The main difference is that the resistor and capacitor are swapped, so that the 555 output goes high when the capacitor is discharged rather than when it is charged. Pressing the button discharges the capacitor, and it takes about two minutes to charge up again.

To drive a relay, be sure to use a conventional bipolar 555 (NE555, LM555), not the CMOS 7555, LMC555, or TLC555—they can't source enough current. Even so, the relay coil must not draw more than 200 mA. Diode D1 protects the 555 from inductive kickback.

## The Third Wire

**Q** *Why does my laptop computer battery pack have three wires instead of two? — R. A. B., Falmouth, VA*

**A** The third wire probably goes to a temperature sensor that is used to control fast charging.

## Point of Grammar

**Q** *Why do you further the misuse of the English language by speaking of "an LED" ("Q&A," August 1997, page 8, Fig. 2)? — D. W. E., Nappannee, IN*

**A** It's not an error. The usage of *a* and *an* depends on pronunciation, not spelling. We pronounce LED as "ell ee dee," which begins with a vowel sound, so we put *an* in front of it. If you pronounced it "led," you would of course say "a LED."

## Conductive Rubber For LCD

**Q** *According to your statement at the end of the Q&A page, you welcome questions. I am sorry to say that through all the years I have subscribed to your magazine, I have never received an answer to any of my questions. I hope that you will answer the following:*

*In your August 1997 issue, pg. 8, you described the conductive rubber that is used under LCD displays. I have a Precision Data multimeter that uses this material. Apparently, my conductive strips have aged and are not conducting properly. Do you know where I can purchase these strips and how they are identified? — W. B. H., Knoxville, TN*

**A** We regret that we can answer only about a third of the questions we receive. Space limitations are the biggest reason; also, we choose questions that are of wide interest and that we can answer reliably. (Even we don't know everything!)

Sometimes, when a question is a real puzzler, we throw it open for readers to answer. That's what we're going to do with yours, since we've never seen the

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Many electronic component manufacturers have Web pages; see the directory at http://www.hitex.com/chipdir/, or try addresses such as http://www.ti.com and http://www.motorola.com (substituting any company's name or abbreviation as appropriate). Many IC data sheets can be viewed online. Extensive information about how to repair consumer electronic devices and computers can be found at www.repairfaq.org.

**Books:** Several good introductory electronics books are available at RadioShack, including one on building power supplies.

An excellent general electronics textbook is *The Art of Electronics*, by Paul Horowitz and Winfield Hill, available from the publisher (Cambridge University Press, 1-800-872-7423) or on special order through any bookstore. Its 1125 pages are full of information on how to build working circuits, with a minimum of mathematics.

Also indispensable is *The ARRL Handbook for Radio Amateurs*, comprising 1000 pages of theory, radio circuits, and ready-to-build projects, available from the American Radio Relay League, Newington, CT 06111, and from ham-radio equipment dealers.

**Copies of past articles:** Copies of past articles in **Electronics Now** and **Popular Electronics** (post 1993 only) are available from our Claggk, Inc., Reprint Department, P.O Box 4099, Farmingdale, NY 11735; Tel: 516-293-3751.

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Manuals for older test equipment and ham radio gear are available from Hi Manuals, PO Box 802, Council Bluffs, IA 51502, and Manuals Plus, PO Box 549 Tooele, UT 84074.

**Replacement semiconductors:** Replacement transistors, ICs, and other semiconductors, marketed by Philips ECG, NTE, and Thomson (SK), are available through most parts dealers (including RadioShack on special order). The ECG, NTE, and SK lines contain a few hundred parts that substitute for many thousands of others; a directory (supplied as a large book and on diskette) tells you which one to use. NTE numbers usually match ECG; SK numbers are different.

Remember that the "2S" in a Japanese type number is usually omitted; a transistor marked D945 is actually a 2SD945.

**Hamfests (swap meets) and local organizations:** These can be located by writing to the American Radio Relay League (Newington, CT 06111; http://www.arrl.org). A hamfest is an excellent place to pick up used test equipment, older parts, and other items at bargain prices, as well as to meet your fellow electronics enthusiasts—both amateur and professional.

special rubber material for sale as a separate item either. (As explained in November, it's not just a hunk of conductive rubber or plastic; it consists of conductive strata separated by insulators to prevent cross-connections.) Our first suggestion would be that you might ask Precision Data whether they can supply it as a replacement part; after all, their LCD display is probably custom-made. Alternatively, can a reader help?

## Pinball Wizard Found

*In your September 1997 issue, you had someone wanting old Gottlieb parts. Most parts for pinball machines can usually be obtained at local distributors, but Gottlieb is out of business. The only place I know of so far that has parts for their machines is Two Bit Score, 4418 Pack Saddle Pass, Austin, TX 78745, Tel: 512-447-8888. — Staci Steddum, Wichita, KS*

## Writing to Q&A

That's all for this month. As always, we welcome your questions; please write to: "Q&A," **Electronics Now** Magazine, 500 Bi-County Blvd., Farmingdale, NY 11735. The most interesting ones are answered in print. Please be sure to include plenty of background information (we'll shorten your letter for publication). *If you are asking about a circuit, please include a complete diagram.* Due to the volume of mail, we regret that we cannot give personal replies. **EN**

BY JEFF HOLTZMAN
COMPUTER EDITOR

# The platform is the UI

WE'VE BEEN RUBBING OUR NOSES PRETTY DEEPLY IN PALMPILOT PROGRAMMING THE PAST FEW MONTHS. I THINK WE'VE GOTTEN A PRETTY GOOD IDEA OF WHAT'S INVOLVED, INCLUDING THE CAPABILITIES AND LIMITATIONS OF the target platform, the development tools, and the development process. It's time now to back up a little, take stock of where we've been, why we went down that path, and chart a new direction.

I was initially attracted to the PalmPilot for some pretty mundane reasons—basically, I thought it would help me solve some pretty mundane problems, such as appointment tracking, time and billing, and the other things that an organizer should do. After purchasing my Pilot, I quickly realized that there was more to it than just a better (or at least more modern) way of getting organized.

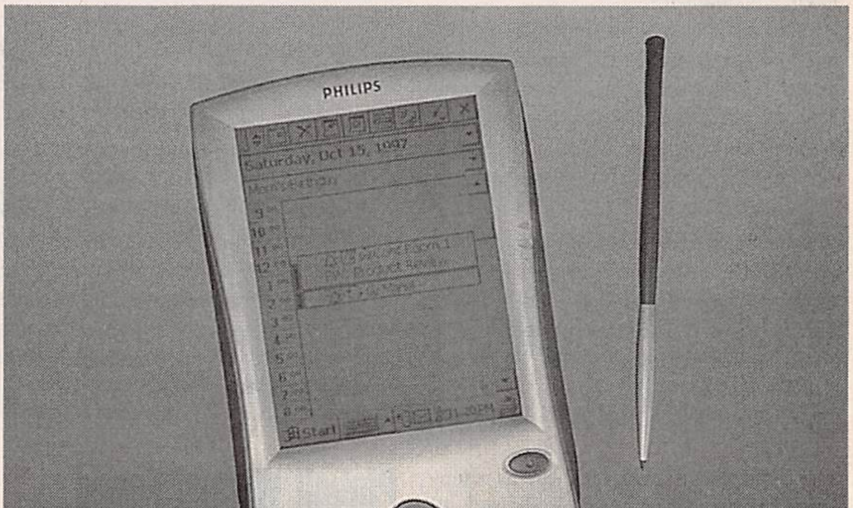
My view of just what that "more" amounts to has evolved over the past year, but in essence in comes down to this: Probably unintentionally, the Pilot has become the first serious challenge to the Wintel platform since perhaps the introduction of the Macintosh. No, I'm not suggesting that the Palm OS will soon or ever overtake Windows, or that the Dragonball 68K CPU is going to put Intel out of business.

What Palm has done is create a new *platform*. In the computer business, the term *platform* usually denotes a CPU family, a hardware architecture, and an operating system. For our purposes, I want to use the term somewhat differently. Here it means an intellectual, business, and even cultural magnet, with increasing momentum, like a snowball rolling downhill.

This new *platform* is making Palm (3Com) a little more successful as a company. It is also spawning a slew of other companies building products to complement the platform. Those products span a broad range, including system hacks, utility programs, application programs, accessories such as styli and cases, peripherals such as keyboards and IRDA connectivity (soon), and even complete OS replacements for special markets and other languages. Most importantly in our hype-ridden age (witness Java), it shows that another platform can be a viable business proposition.

That has all happened in a very short period of time—less than two years. There is excitement among both users and developers unlike anything I've seen for a long time. To many of us, the whole phenomenon is strongly reminiscent of the early and mid eighties, when the PC *platform* was starting to take off.

The surest sign that what I'm saying is true is the way Microsoft is scrambling to produce a workable version of Windows CE, and the way the hardware manufacturers such as Compaq, HP, TI, Casio, and Philips are scrambling to evolve their designs to track that of the Pilot. As I write this, CES is just a few




THE NINO 300 FROM PHILIPS is one of the first of a new generation of palm computers that use the Windows CE 2.0 operating system. It is designed to compete directly with the PalmPilot.

days away. At that show, Microsoft's Gryphon (read: Pilot wannabe) *platform* will be released. It is going to be very interesting to see what happens this year as the first Gryphon machines are released, coincident with the third generation of Palm devices.

### The UI is the Problem

Now zoom out. In the overall landscape, there is probably a 200:1 ratio between Wintel machines and PalmPilots. Further, they don't even compete, right? So why is Microsoft so worried? Perhaps because the race is not yet over.

The race? What race? The race to mature-industry status, like automobiles, washing machines, refrigerators, even telephones.

With the advent of pretty darn capable \$1000 machines the past year or so, it could be argued that PCs have reached commodity status; that is, that they are distinguished more by price and marketing than by technology and innovation.

The problem is the user interface. And (as always) I don't simply mean the arrangement of GUI elements on a screen. I'm talking about the whole *gestalt* of the computer experience. Some of it is technology driven; some, socially driven. To begin with the latter, there has to be a certain level of invisible social awareness and comprehension of a technology for it to become truly ubiquitous, like the automobile.

Nearly every normal person in our society knows what an automobile is, what is its purpose, and how to use it. Usage training is an integrated part of growing up. Not so with computers, not by a long-shot. And why not? Because they are too hard to use.

I don't mean that word processors or windowing systems themselves are too hard to use. I mean that the whole experience of computing is too hard for most people. This means system-level stuff like fragile configuration management, system and data vulnerability, maintenance, and upgrades.

Think about it. How many (nontechnical) users do you know who don't do backups? Has your machine ever been trashed by a corrupt registry? How do you handle system and application software upgrades? Hardware upgrades? System transfers?

What we need are "unbreakable" systems. (Spare me; I'm well aware nothing is truly unbreakable.) At a minimum, systems that you would have to consciously rather than inadvertently or ignorantly break.

Perhaps some examples will make things clearer. Suppose we had a system that:

- Password-protects all system-level resources so that you couldn't accidentally format your C drive, or erase all the DLLs in your system directory;
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*(Continued on page 26)*

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# Prototype

## On The Floor at CES

If you've never attended a mega trade show like the Winter Consumer Electronics Show, the experience is hard to describe adequately. Part serious business forum, part crazed carnival on steroids, it could only be held in Las Vegas—a city where it is very hard to tell reality from fantasy.

Usually, the show produces lots of heat and smoke, but little fire. Occasionally, however, a trend or product that will profoundly affect some part of our lives will make its first appearance on the show floor. Thanks in part to the FCC's ruling on DTV (digital TV), this was one of those rare years.

### Be Digital or Be Square

Despite the fact that no one, including broadcasters and manufacturers, is really quite sure what shape digital TV will take, and despite the fact that DVD sales, while "acceptable" for a first year product, fell quite a bit short of the hype that accompanied its introduction, it seemed that every manufacturer found some way to work the word "digital" into their product offerings. But without a doubt, the 800-pound gorilla of the show was DTV. Every manufacturer of television sets, video displays, or any type of video product, had to deal with the coming change in standards in some way.

Of course, the ones most directly impacted were the set manufacturers. Without exception, every company from the major players to the smallest supplier of off-brand sets from the Pacific Rim showed some type of DTV, and most showed wide-screen models. Most manufacturers expect that initial buyers will be the so-called "early adopters" who generally have excess funds at their disposal and want to be the first on the block with the latest technological advances. As such, most of the initial DTV products will be high-end, high-cost, large-screen 16:9 models capable of producing a full 1080-line (interlaced) HDTV image.

But what about the rest of us? The full switch to DTV is not scheduled until 2006 at the earliest. However, most feel that even that target date is unattainable. Because of that, manufacturers are bringing a new generation of "DTV-ready" analog sets to market. Those sets look and work just like the TVs we are all accustomed to, but include component-video and/or RGB inputs. Typically, manufacturers will be adding these features to their higher-end, large-screen models first. A few models are already available—in fact, high-end video projectors with RGB inputs have been available for many years—with many more slated to be available by this fall.

Of course, if a DTV-ready set is to receive a DTV broadcast, some type of set-top decoder box will be needed. Again, almost everyone had black-box prototypes, but most manufacturers were vague about costs and delivery dates. One exception was Zenith, which announced that they would have a full-featured decoder available this spring. The cost? It carries a suggested list price of $5995.

Of course, not all the digital news was DTV. Almost all manufacturers announced new DVD offerings. Among other things, this coming year will see DVD changers and portable DVD players. Several manufacturers announced DIVX players, though others were vague about plans to support the controversial DVD-derivative format. For more on DIVX, see the Editorial in the December 1997 issue of **Electronics Now.**


MOST OF THE FIRST DTV PRODUCTS are slated to be wide-screen, high-end models like this 64-inch rear-projection model from Philips.

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## The Shape of TV

We already know that, thanks to DTV, one of the future shapes of television will be wide. However, to that you might also be able to add flat and round.

A flat TV that consumers could hang on a wall just like a picture has been a holy grail for the consumer-electronics industry for decades. Now, that grail is finally within reach. Nearly every TV manufacturer had a large-screen, 16:9 format, flat-panel set on display. Nearly all were based on plasma technology (Sharp showed one that was a plasma/LCD hybrid), nearly all were prototypes (though a few are scheduled to ship this year and one should be available by the time you read this), and all were very expensive ($11,000 and up). Typically, the sets on display were no more than about 4-inches thick and sported screen sizes of 42 inches (diagonal). For more on the technology behind these sets, see "Get the Big Picture" elsewhere in this installment of "Prototype."


DURING THE TRANSISTION TO DTV, most manufacturers will be offering DTV-ready analog sets like this 36-inch model from Sharp.

OK; we've taken care of wide and flat, but round? Believe it or not, one small company, ESP Electronics, was demonstrating a "360-Degree Television" that produces a 19-inch picture and offers in-the-round theater-style viewing to watchers seated on all sides of the unit.

There were a couple of drawbacks, however. One was cost; the unit is slated to be limited to a collectors-edition run of 1000 sets, each with a price of $40,000. The other was that the unit on display suffered from extreme flicker. Talking to company officials, we learned that they had solved the problem, but did not have enough time to implement that solution prior to the show.

## Other News

A show as large and diverse as CES is difficult to fully summarize in the space we have available, but there were a few other noteworthy trends and developments.

Home security and the Internet would seem like topics that are far removed from each other, yet products and systems that used the Internet in home-security and remote-control applications were shown by several companies, including Intel. One company, emWare, demonstrated a prototype Weiser "Powerbolt" door lock that can be controlled over the Internet using their software.

The much ballyhooed V-Chip also made its debut at CES. The Telecommunications Act of 1996 required the V-Chip to be incorporated into new TV designs beginning this

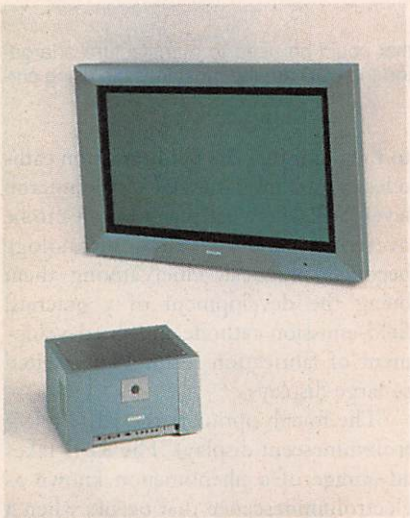
TO RECEIVE DIGITAL SIGNALS ON AN ANALOG SET, a viewer will need a set-top box. One of the first on the market is this unit from Zenith.

year. For those who want to exercise parental control without buying a new set, Tri-Vision had on display four outboard units that work with existing sets and the current TV-rating system to electronically control youngsters' access to TV programming. The inventor of the V-Chip, Tim Collings, is on Tri-Vision's board of directors.

PANASONIC WILL BE OFFERING a portable DVD player later on this year.

Another product that generated some attention was Philips new audio CD recorder. Though technically not a new introduction—it has been available at a few select retailers since the fall—it will be distributed to mainstream electronics retailers during the coming year. The recorder allows home users to make their own CDs, which will have all the features and quality of professionally produced discs. To prevent unregulated disc duplication, the player supports the various international copy-protection agreements.

In the midst of all of this future technology, there were also a few islands of nostalgia. A couple of companies exhibited specialty radios with a distinctly antique look. One even sported an antique name—Crosley Radio.



USING PLASMA-DISPLAY TECHNOLOGY,large screen flatTVs like this unit from Philips have finally become a reality.

PRESIDENT CLINTON is seen here holding a prototype V-Chip board. Tri-Vision will be offering add-on V-Chip units designed to work with existing sets.

A few noteworthy technologies were also on exhibit off the main floor. One company, NUWAVE, was demonstrating its video-processing technology in a suite at the Riviera Hotel. That technology, already available in a standalone processor aimed at the professional market, improves image clarity, color, contrast, and brightness. Particularly striking was the fact that the processor can increase an image's apparent dynamic range—deeper black levels can be set without affecting the white levels of the image. From a viewer's point of view, that means that details can be brought out of shadows or dark areas without adversely affecting the rest of the image. Among the plans discussed were a possible mass-market consumer product and the availability of the technology on an ASIC IC for OEMs. Shortly after the show's end, NUWAVE announced that they had signed an agreement with Thomson (manufacturers of RCA, GE, and ProScan sets) to include their video-processing ASIC in that company's future products.

On the computer side, Microsoft had a major presence at this year's show as it launched its Windows CE 2.0 operating system. One application for the new OS is in Palm computers, and several manufacturers announced units that made use of it. For more on that, see "Computer Connections" elsewhere in this issue of **Electronics Now.**

WHEN MICROSOFT TALKS about its "Windows Everywhere" philosophy, they mean what they say as evidenced by this Auto PC that runs on the new Windows CE 2.0 operating system.

However, Palm computers are not the only application for CE 2.0. There is perhaps no better demonstration that Microsoft meant what it said with its "Windows Everywhere" philosophy than the Auto PC.

The Auto PC is an in-dash automo-

tive computing system. Built around the CE 2.0 platform, Auto PC adds speech-recognition technology, a visual interface, and other car-oriented features to create "an information and entertainment device" for the automobile. An Auto PC unit can be used to send and receive e-mail, dial a cell phone, locate and/or navigate to a location, obtain weather and traffic information, and control the car's entertainment system (radio, CD, etc.). Through the use of speech recognition, all of that could be accomplished without the driver taking his hands off the wheel or his eyes off the road. PT

# Get The Big Picture

Since at least the 1950s, researchers have said that a practical large-screen, flat, wall-hanging TV display was about ten years away. Well, after nearly a half-century, those ten years have finally passed. At the just concluded CES, nearly every manufacturer of TVs showed some type of large-screen (typically 42-inches diagonal measure, 16:9 aspect ratio) flat-panel TV. While some remain prototypes, several manufacturers plan to ship units this year, with at least one scheduled to be on the market by the time you read this. For more information on those, see "On the Floor at CES" elsewhere in this installment of "Prototype." In this article, we will be looking at the technology that has made those flat TVs finally a reality.

## Flat Panel Technology

There are four technologies that can be used to create a large, flat display. Those are summarized in Fig. 1.

The first is the LCD (liquid crystal display). LCDs have the ability to change the light transmission coefficient

FUJITSU'S PLASMAVISION 42EP is a second-generation, DC, PDP flat-panel display that is now commercially available. It carries a suggested price of $10,999.

of a liquid crystal. Generally, small fluorescent lamps are placed behind the screen to serve as a backlight. The strength of the light transmitted from the backlight is modulated to display text, graphics, and other information. Today LCDs are mass produced in sizes of several inches to well over ten inches for use in small television sets, word processors, and personal computer terminals. TFT-LCDs have TFTs (thin film transistors) on every picture element (pixel) for excellent image reproduction. The drawback to this technology is that the displays are complex devices, and making them requires every bit as much precision as manufacturing

PDPs are best imagined as a huge number of tiny fluorescent lamps squeezed between two sheets of glass. PDPs have the advantage of simplicity of structure, which makes them a practical choice even for screens of more than 40 inches, and because they are based on the light emitted by phosphors, they are easy to colorize to achieve natural-looking color reproduction.

The third choice is the FED (field-emission display). FEDs have a large number of field-emission cathodes arrayed on a plane. Those cathodes emit electron beams that excite phosphors. The technology was made possible by advances in semiconductor technology

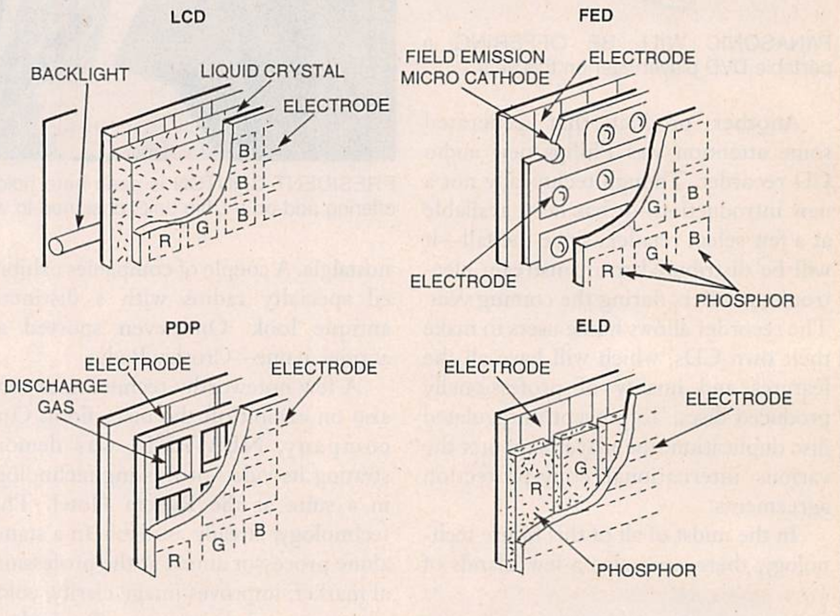



FIG. 1—FOUR POSSIBLE TECHNOLOGIES that could be used to manufacture a large-screen, flat-panel display. Of the four, the PLD and the LCD are the most feasible using current technology.

integrated circuits. Because of that, it is currently impractical, both in terms of technology and production investments, to manufacture anything much larger than a 40-inch LCD panel.

The second option is the PDP (plasma display panel). In a PDP, a panel of microscopic plasma-discharge cells are closely arrayed along vertical and horizontal axes. PDPs work under the same principle as fluorescent lamps. Information is displayed by adjusting the duration of the discharge by controlling the electrodes of every single cell. An electrical discharge generates ultraviolet waves that excite phosphors. Perhaps

to the point that the field-emission cathodes can be miniaturized to the micron level. Still, there are many hurdles to be overcome before the technology becomes practical, chief among them being the development of a practical field-emission cathode and the development of fabrication technologies suited to large displays.

The fourth option is the ELD (electroluminescent display). The ELD takes advantage of a phenomenon known as electroluminescence that occurs when a strong electric field is applied to a phosphor. Ten-inch ELDs emitting yellow-orange light are already on the market,

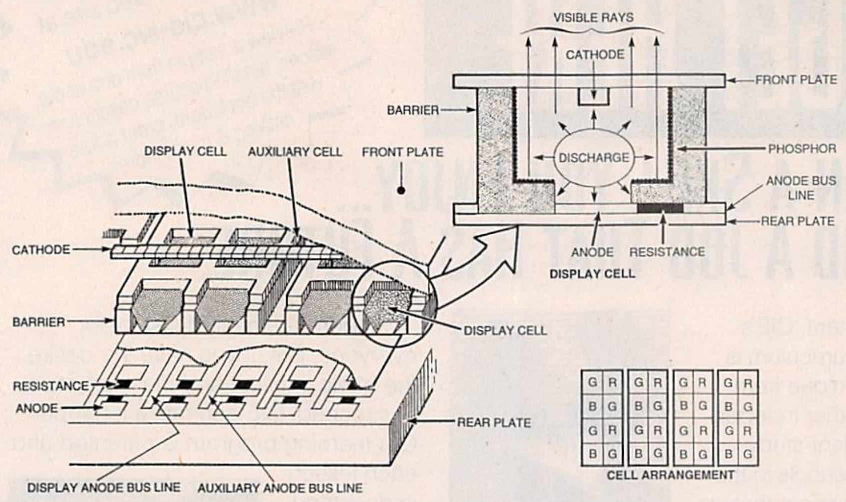



**FIG. 2—INSIDE A DC PLD.** By adding auxiliary cells and by adding extra green cells, developers have improved image quality to the point where it is suitable for HDTV use.

and there has recently been a surge in research on electroluminescent materials able to give off the three primary colors with high levels of brightness and luminance. Some manufacturers have even created prototypes of small multicolor displays. Application to larger screens will, however, require improvements in brightness and luminance.

Among all of these possible technologies, the ones most practical for large-screen displays using present-day technology are LCDs and PDPs. However, as discussed above, while LCDs are commonly used in small-screen applications, such as in portable computers, there are many technological and cost hurdles in creating a practical large-screen LCD display.

One possible way around those problems might be a hybrid technology called PALC (plasma addressed liquid crystal) that combines the two. In a PALC, an LCD layer is placed on top of a PDP. The "plasma addressing" plays the same role as transistor switching for TFT-LCDs; when the plasma discharges, the same thing occurs as if the transistor switch were shut. That enables the transmission coefficient of the liquid crystal to be changed and therefore the brightness to be regulated.

PALCs require a backlight just as conventional LCDs do. However, they do not require large numbers of transistors formed over a large surface, so they are potentially viable for larger screens. Unfortunately, they also suffer from the LCD's most characteristic problem—the brightness and contrast differs depending upon the viewing angle. Solving that problem will be essential for the technology to catch on. Still, the technology is promising enough for three major manufacturers—Sharp, Sony, and Philips—to join forces to develop a practical set, and Sharp demonstrated a prototype PALC at CES.

That said, the technology most manufacturers are turning to is the PDP, and aside from the Sharp PALC, every large-screen flat-panel display shown at CES was of that type. Let's look a little more closely at the PDP.

## Inside the PDP

PDPs come in two varieties, AC and DC. In the AC version, the electrode is covered by the dielectric layer and operated with alternating current. The AC PDP has the advantages of structural simplicity, easy fabrication, and lower production costs, and their screens provide almost as much detail as conventional televisions. But while they are bright enough, they still have problems with contrast and with picture quality when moving images are displayed.

The DC version exposes the electrode to the discharge space and operates under direct current. Let's look at it in more detail (see Fig. 2).

Getting a clear picture out of a PDP requires that all of the display cells discharge in a stable manner. In practical terms that requires that display cells produce other stable discharges in addition to those for the display of information (display discharges). Those are called "auxiliary discharges," and without them the screen looks like a fluorescent lamp when it is first turned on, blinking and flickering erratically. However, because the PDP has stable auxiliary discharges taking place within its display cells, fluorescent light is being generated even during dark scenes, resulting in a lack of contrast. The brightness and darkness of the screen is controlled by changing the discharge duration of individual cells, but when fast movements are displayed, the picture quality rapidly deteriorates—faces take on lines that make them look like the contour lines on maps.

The DC PDP gets around those problems by adding auxiliary cells that do nothing but produce the auxiliary discharges, thereby preventing any declines in contrast. The developers also rethought the entire concept of using discharge duration to control brightness, with a marked improvement in picture quality especially for fast movement. They have tinkered with cell arrangement as well. Display cells are typically arranged with one cell of red, another of green, and another of blue in a horizontal formation. Green, however, plays a large part in screen sharpness, so the developers have put one cell of green after each cell of the other two colors. That arrangement of green cells has improved display resolution to the point where it is suitable for Japan's Hi-Vision (HDTV) broadcasts.

Still, despite the excitement from some display manufacturers, there are serious hurdles that must be overcome if PDPs are to be accepted in the public's living rooms. One huge one is cost. Pricing for the first units is high, running in the low to mid five figures. It is reasonable to expect those costs to go down with time, but for that to happen will require improvements in the panel production processes, an increase in the yield of the panels that can be used, and improvements in the drive circuit (which is costlier because it uses a higher operating voltage than LCDs). One industry spokesman predicted a cost of $100/inch in a few years. That means that a 42-inch PLD display would cost a still-high $4200.—PORTIONS BY NISHIZAWA TAIJI, COURTESY LOOK JAPAN (SEPTEMBER 1997) PT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# EQUIPMENT REPORT

## FLUKE MODEL 77 III DMM

*Fluke's 77 Series III DMM brings a fresh new look to the world of multimeters.*

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In terms of appearance, not much has changed over the years when it comes to common digital multimeters, or DMMs. Show any technician or experienced hobbyist any DMM from just about any manufacturer, and he or she will be instantly able to use it. That's because, for the most part , just about all DMMs look and work the same.

Why? Well, for one thing, most of the advances in meter technology have centered around performance and features, with styling, ergonomics, and the user interface taking a back seat for the most part. Besides, to most manufacturers it likely seems to make sense not to mess with a good thing.

It takes guts for a major manufacturer to change something that people are accustomed to, like the elimination of tail fins from cars in the early 1960s or the transition from analog multimeters to digital ones—customers just might not accept something that's new and different. That's why Fluke's move to change the design of a basic multimeter is a bold one. However, after having the opportunity to use one of the redesigned meters, this reviewer feels it is one that should be embraced by technicians worldwide. Fluke's 70 Series III and 20 Series III Digital Multimeters have a bold, new design that sets them apart from DMMs of the past and paves the way for more unusual designs in the future.

**Electronics Now** took a look at Fluke's model 77 III multimeter, a $179 DMM with a unique design that tapers down at the bottom making it easier to hold, especially for people with small hands. It also sports what Fluke calls an overmolded case. Fluke has basically taken the rubber holster that's been used on upscale DMMs in the past, and permanently fused it to the harder plastic case in what must be a really neat process. The result is a sleek multimeter with permanent cushioning around its outer surfaces. Fluke is confident that the meter is well protected because it's backed by a lifetime warranty. As long as the original purchaser owns it, Fluke will repair or replace it according to specified terms.

Anti-skid rubber feet, the same color as the case, are fused to the back of the meter—it's hard to see that they're there, but you can feel them and they do prevent the meter from sliding around while lying on a workbench or another surface. Making the outer cushioning a permanent part of the meter yields a slimmer, lighter instrument that's easier to work with. A flip-out hook on the back of the meter can be used to attach the meter to a vertical rod or cable, and there's a flip-out stand as well. The meter is $7^3/_8$ inches tall, $3^1/_2$ inches wide at the top, $2^3/_4$ inches wide at the bottom, and $1^3/_8$ inches high. It comes with a pair of rugged, non-slip, "rubberized" test leads.

### The 77 III

High voltage is tough on a meter, but Fluke's 77 III DMM can take it. It has overvoltage protection against spikes up to 6 kilovolts—the meter is even safe if it's accidentally set to measure ohms. Model 77 III is IEC 1010 safety rated. This standard defines four overvoltage categories based on the magnitude of danger. The meter is rated for 6 kilovolts CAT I, 1000 volts CAT II, and 600 volts CAT III. The current inputs are fuse-protected.

The high-contrast LCD has been made 40% larger, with four digits measuring $^5/_8$-inches tall. The display has an analog bargraph along its bottom edge. A single rotary knob in the center of the meter is used to select the operating mode. The meter defaults to autorange mode, which can easily be overridden by pressing a Range button. A Touch-Hold mode automatically captures the measurement, beeps, and locks it on the display for later viewing.

Measurements for the 77 III DMM include AC and DC voltage up to 1000 volts, DC millivolts, resistance up to 32 megohms, and AC and DC current up to 10 amperes continuous. There's also a diode and audible continuity test.

A lot of unusual accessories are available from Fluke. Those include pin-grabber hooks, large-jaw alligator clips, an insulation piercing clip, industrial test leads, flexible straight test leads, an infrared temperature probe for non-contact temperature measurements, a thermocouple module, an immersion probe for liquids and gels, a stainless-steel piercing probe suitable for food service, an exposed probe for air and gas measurements, a pipe-clamp temperature probe, and more. Fluke is obviously prepared to take technicians into the next millennia with its new line of DMMs.

For more information on the model 777 Series III DMM, contact Fluke directly (Fluke Corporation, P.O. Box 9090, Everett, WA 98206; Tel: 800-44 FLUKE; Web: www.fluke.com), or circle 15 on the Free Information Card. EN

BY SAM GOLDWASSER
SERVICE EDITOR

# CD Information Storage and Playback

BEFORE WE CAN GET INTO THE NITTY-GRITTY OF REPAIRING A CD PLAYER OR CD-ROM DRIVE, WE NEED A LITTLE MORE INFORMATION ON HOW CD INFORMATION STORAGE AND PLAYBACK WORKS. LET'S TACKLE THAT NEXT.

The actual information to be recorded on a CD undergoes a rather remarkable transformation as it goes from raw audio (or digital data) to microscopic pits on the disc's surface. For commercial or professional audio recording, the process starts with pre-filtering to remove frequencies above 20 kHz. It continues with analog-to-digital conversion, usually at a sampling rate of 48K samples/second for each stereo channel. The resulting data stream is then recorded on multi-track digital magnetic tape. All mixing and pre-mastering operations are done at the same sampling rate. The final step is conversion through re-sampling (sample-rate conversion including sophisticated interpolation) to the 44.1K samples/second rate actually used on the CD (88.2K total for both channels). (In some cases, all steps may be performed at the 44.1 K rate.) That is followed by sophisticated coding of the resulting 16-bit "two's-complement" samples (alternating between L and R channels) for the purpose of error detection and correction. Finally, the data is converted to a form suitable for the recording medium by Eight-to-Fourteen modulation (EFM) and then written on a master disc using a precision laser cutting lathe. A series of electroplating, stripping, and reproduction steps then produce multiple "stampers," which are used to actually press the discs you put in your player. Of course, it is possible to create your own CDs with a modest priced CD-R recorder (which does not allow erasing or re-recording), and now with re-writable CD technology with fully reusable discs that allow editing similar to what can be done using cassette tape.

Like a phonograph record, the information is recorded in a continuous spiral. However, with a CD, that track (groove or row of pits—not to be confused with the selections on a music CD) starts near the center of the CD and spirals counterclockwise (when viewed from the label side) toward the outer edge. The readout is through the 1.2 mm polycarbonate disc substrate to the aluminized information layer just beneath the label. The total length of the spiral track for a 74-minute disc is over 5000 meters—which is more than 3 miles in something like 20,000 revolutions of the disc!

The digital encoding for error detection and correction is called the Cross Interleave Reed Soloman Code, or CIRC. To describe that as simply as possible, the CIRC consists of two parts: interleaving of data so that a dropout or damage will be spread over enough physical area (hopefully) to be reconstructed and a CRC- (Cyclic Redundancy Check) like error-correcting code. Taken together, those two techniques are capable of some remarkable error correction. The assumption here is that most errors will occur in bursts as a result of dust specs, scratches, or imperfections such as pinholes in the aluminum coating, etc. For example, the codes are powerful enough to totally recover a burst error of greater than 4000 consecutive bits—about 2.5 mm on the disc. With full error correction implemented (that is not the case with every CD player), it is possible to put a piece of 2-mm tape radially on the disc or to drill a 2-mm hole in the disc, and have no audio degradation. Some test CDs have just this type of defect introduced deliberately.

Two approaches are taken with uncorrectable errors: interpolation and muting. If good samples surround bad ones, then linear or higher-order interpolation might be used to reconstruct the bad samples. If too much data has been lost, the audio is smoothly muted for a fraction of a second. Depending on where those errors occur in relation to the musical context, even such drastic measures might be undetectable to the human ear.

Note that the error correction for CD-ROM formats is even more involved than for CD audio as any bit error is unacceptable. That is one of many reasons why it is generally impossible to convert an audio CD player into a CD-ROM drive. However, since nearly all CD-ROM drives are capable of playing music CDs, much can be determined about the nature of a problem by first testing a CD-ROM drive with a music CD.

## Compact Disc Construction

As the following discussion proceeds, we will be expanding on some of the concepts introduced above.

The information layer uses "pits" as the storage mechanism. Pits are depressions less than 0.2 µm (1 µm = 0.001 mm = 0.000001 meter = 1/25,400 of an inch) in depth (1/4-wavelength of the 780-nm laser light, taking into consideration the actual wavelength inside the polycarbon-

ate plastic). Thus, the reflected beam is 180 degrees out of phase with incident beam making for high-contrast edges and good signal-to-noise ratio. Everything that is not a pit is a "land". Pits are about 0.5-μm wide; their length varies with the information content—with each bit being represented by a 0.278-μm increment.

Each byte of the processed information is converted into a 14-bit run-length-limited code taken from a code book (lookup table) such that there are no fewer than two or more than ten consecutive 0s between 1s. By then making the 1s transitions from pit to land or land to pit, the minimum length of any feature on the disc is no less than 3P and no more than 11P, where P is 0.278 μm. This is called Eight-to-Fourteen Modulation—EFM. Thus the length of a pit ranges from 0.833 to 3.054 μm.

Each 14-bit code word has 3 additional sync and low-frequency-suppression bits added, for a total of 17 bits representing each 8-bit byte. Since a single bit is 0.278 μm, a byte is then represented in a linear space of 4.72 μm. EFM in conjunction with the sync bits assures that the average signal has no DC component and that there are enough edges to reliably reconstruct the clock for data readout. These words are combined into 588-bit frames (see Table 1). Each frame contains 24 bytes of audio data (6 samples of L+R at 16 bits) and 8 bits of information used to encode (across multiple frames) information like the time, track, index, etc.

A block, which is made up of 98 consecutive frames, is the smallest unit that can be addressed on an audio CD and corresponds to a time of $^1/_{75}$ of a second. Two bits in the information byte of each frame are currently defined. These are called P and Q. P serves a kind of global sync function, indicating start and end of selections, time in between selections, and so forth. The 98 Q bits of each block encode the time, track and index number, as well as many other possible functions depending where on the disc it is located, what kind of disc it is, and so forth.

Information on a CD is recorded at a Constant Linear Velocity—CLV. That is both good and bad. For CD audio at 1× speed, this CLV is about 1.2 meters per second. (It really isn't quite constant—due to non-constant coding packing density and data buffering—but instead varies between about 1.2 and 1.4 meters-per-second). CLV permits packing the maximum possible information on a disc since it is recorded at the highest density regardless of location.

However, for high-speed access, particularly for CD-ROM drives, it means there is a need to rapidly change the speed of rotation of the disc when seeking between inner and outer tracks. Of course, there is no inherent reason why, for CD-ROMs, the speed could not be kept constant meaning that data transfer rate would be higher for the outer tracks than the inner ones. Modern CD-ROM drives with specs that sound too good to be true (and are), may run at constant angular speed achieving their claimed transfer rate only for data near the outer edge of the disc.

Note that unlike a turntable, the instantaneous speed of the spindle is not what determines the pitch of the audio signal. For one thing, there is extensive buffering in RAM inside the player. That buffering is used as a FIFO to smooth out data read off of the disc to ease the burden on the spindle servo, as well as to provide temporary storage for intermediate results during decoding and error correction. Pitch (in the music sense) is instead determined by the data readout clock—usually a crystal oscillator—which controls the D/A and LSI chip-set timing. The only way to adjust the player's pitch is to vary that clock. Some high-end players include a pitch adjustment that does just that.

Since the precision of the playback of a CD player is determined by a high-quality quartz oscillator, wow and flutter—key measures of the quality of phonograph turntables—are so small as to be undetectable. Ultimately, the sampling frequency of 44.1K samples-per-second determines the audio output. For this, the average bit rate from the disc is 4.321M bits-per-second.

Tracks are spaced 1.6-μm apart—a track pitch of 1.6. Thus, a 12-cm disc has over 20,000 tracks for its 74 minutes of music. Of course, unlike a hard disk and like a phonograph record, it is really one spiral track over 3 miles long! (However, as noted above, the starting point is near the center of the disc.) Compare that to an LP record: A long long-playing LP might have a bit over 72 minutes of music on two sides, or 36 minutes per side. (Most do not achieve anywhere near this much music since the groove spacing needs to vary depending on how much bass content the music has; bass requires wider grooves, and wide grooves occupy more space.) At 33-$^1/_3$ rpm, this is just over 1200 grooves in about 4 inches compared to 20,000 tracks on a CD in a space of just over 1.25 inches! The readout styles for an LP has a tip radius of perhaps 2 to 3 mils (50 to 75 μm)

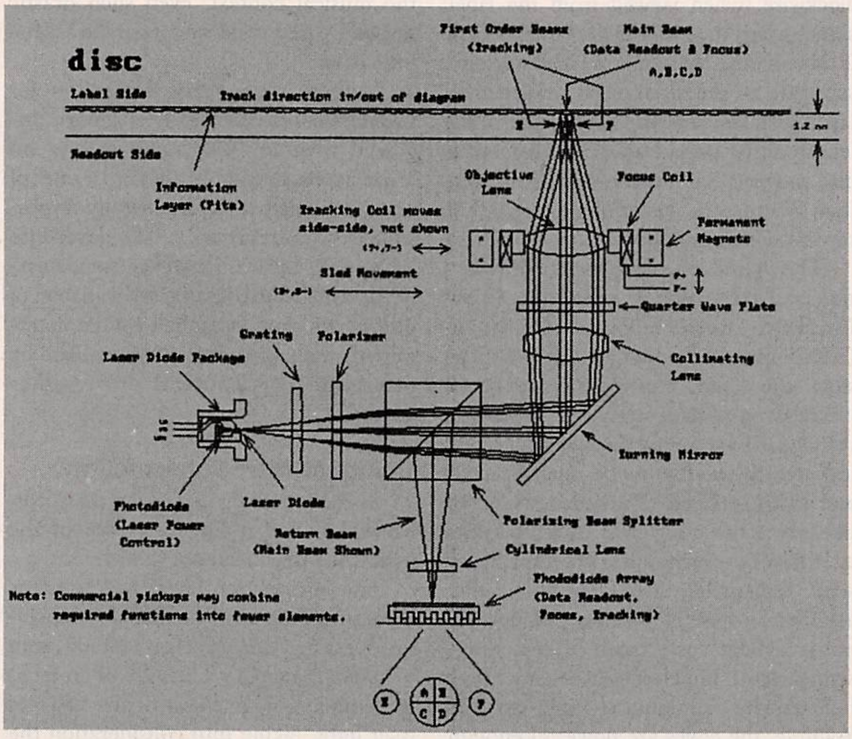



FIG. 1—HOW A TYPICAL THREE-BEAM PICKUP WORKS. Though there are many variations on this design, all pickups work in a similar fashion.

compared to 1 μm for the focused laser beam of a CD player!

At a constant linear velocity of about 1.2 meters per second, the required tracking precision is astounding. To put the required CD player servo-system performance into perspective, here is an analogy: Proper tracking of a CD is equivalent to driving down a 10-foot-wide highway (assuming an acceptable tracking error of less than +/-0.35 μm) for more than 3200 miles for one second of play, or over 14,400,000 miles for the entire disc without accidentally crossing lanes! And you thought that driving on a narrow winding country road was pretty tough!

Actually, it is worse than that: Focus must be maintained all this time to better than 1 μm as well (say, +/-0.5 μm). So, it is more like piloting a aircraft down a 10-foot-wide flight path at an altitude of about 12 miles (4 mm (typical) focal-length objective lens) with an altitude error of less than +/-7 feet while the target track below you is moving both 1 mile horizontally (CD and spindle runout of 0.35 mm) and 3 miles vertically (disc warp and spindle wobble of up to 1 mm) per revolution! In addition, you are trying to ignore various types of garbage (smudges, fingerprints, fibers, dust, etc.) below you, which on this scale have mountain-sized dimensions. (Sorry for the mixed units, and my apologies to the rest of the world where the proper units are used for everything.)

The required precision seems unbelievable, but is just another day in the entertainment center for the CD player's servo systems. Even more surprising, this level of precision is achieved using mass-produced technology that dates to the late 1970s. And, don't forget that a properly functioning CD player is remarkably immune to small bumps and vibration—more so than an old style turntable.

Of course, we better hope that our technological skills are never lost—a phonograph record can be played using the thorn from a rosebush and a potter's wheel for a turntable. As you can see, there's just a bit more technology needed to read and interpret the contents of a CD!

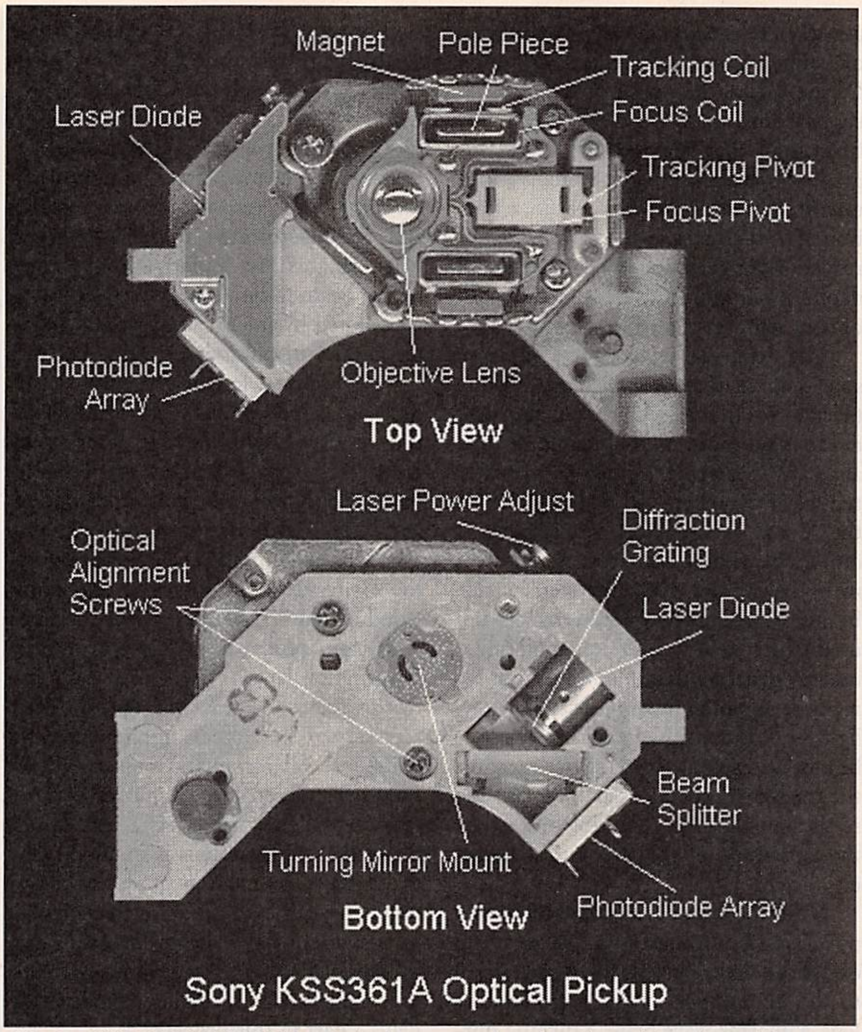



**FIG. 2**—THIS SONY KSS361 is a typical mass-produced modern pickup. It combines multiple functions into fewer distinct parts, resulting in improved robustness and lower cost.

## Optical-Pickup Principles

The purpose of the optical pickup in a CD player, CD-ROM drive, or optical-disk drive, is to recover digital data from the encoded pits at the information layer of the optical medium. For CD players, the resulting data stream is converted into high-fidelity sound. For CD-ROMs or other optical-storage devices, it might be interpreted as program code, text, audio or video multimedia, color photographs, or other types of digital data.

The following (simplified) description of an optical pickup assumes a three-beam device—the most common type. A diagram of the pickup we will be discussing is shown in Fig. 1. To accomplish the same objectives, many variations on this design—such as a single-beam pickup—are possible. In addition, modern mass-produced pickups like the very common Sony KSS361A model shown in Fig. 2 combine multiple functions into fewer distinct parts. The result is improved robustness and lower cost. However, most of the basic operating principles are similar.

It is often stated that the laser beam in a CD player is like the stylus of a phonograph turntable. While this is a true statement, the actual magnitude of this achievement is usually overlooked. Consider that the phonograph stylus is electromechanical. Stylus positioning—analogous to tracking and focus in an optical pickup—is based on the stylus riding in the record's grooves and controlled by the suspension of the pickup-cartridge and tone arm. The analog audio is sensed most often by electromagnetic induction produced by the stylus's minute movements wiggling a magnet within a pair of sense coils.

The optical pickup, on the other hand, must perform all of those functions without any mechanical assistance from the CD. It is guided only by a fraction-of-

**TABLE 1**

| | |
|---|---|
| Sync | (24 + 3) |
| Control and Display | (14 + 3) |
| Data | (12 × 2 × (14 + 3)) |
| Error Correction | ( 4 × 2 × (14 + 3)) |
| Total Bits/Frame | 588 |

a-mW of laser light and a few milligrams of silicon-based electronic circuitry. Furthermore, the precision involved is easily more than two orders of magnitude finer than that required for a phonograph. Sophisticated servo systems maintain focus and tracking to within a fraction of a micrometer of optimal. Data is read out by detecting the difference in depth of pits and lands of $^1/_4$-wavelength of laser light (about 0.15 μm in the CD)!

The laser beam is generated by a solid-state laser diode emitting at 780 nm (near IR). Optical power from the laser diode is no more than a couple of mW and exits in a wedge-shaped beam with a typical divergence of 10 × 30 degrees in the X and Y directions, respectively. A diffraction grating splits the beam into a main beam and two (first-order) side beams. (The higher-order beams are not used.) Note that the diffraction grating is used to generate multiple beams, not for its more common function of splitting up light into its constituent colors. The side beams are used for tracking and straddle the track that is being read. The tracking servo maintains this centering by keeping the amplitude of the two return beams equalized.

Next, the laser beam passes through a polarizing beam splitter (a type of prism or mirror that redirects the return beam to the photodiode array), a collimating lens, a quarter-wave plate, a turning mirror, and the objective lens before finally reaching the disc.

The collimating lens converts the diverging beam from the laser into a parallel beam. A turning mirror (optional, depending on the specific optical path used) then reflects the laser light up to the objective lens and focus/tracking actuators.

The objective lens is similar in many ways to a high-quality microscope objective lens. It is mounted on a platform that provides for movement in two directions. The actuators operate similarly to the voice coils in loudspeakers. Fixed permanent magnets provide the magnetic fields that the coils act upon. The focus actuator moves the lens up and down. The tracking actuator moves the coil in and out with respect to the disc center. The collimated laser beams (including the 2 side beams) pass through the objective lens and are focused to diffraction-limited spots on the information-pits layer of the disc (after passing through the 1.2 millimeters of clear polycarbonate plastic that forms the bulk of the disc).

The reflected beam retraces the original path up until it passes through the polarizing beam splitter, at which point it is diverted toward the photodiode array. (The polarizing beam splitter passes the horizontally polarized laser beam straight through. However, two passes—source and return—through the quarter-wave plate rotates the polarization of the return beam to be vertical instead, and it is reflected by the polarizing beam splitter toward the photodiode array.)

A cylindrical lens slightly alters the horizontal and vertical focal distances of the resulting spot on the photodiode array. The spot will then be perfectly circular only when the lens is positioned correctly. Too close or too far and the spot will be elliptical (*e.g.*, elongated on the 45-degree axis if too close, and elongated on the 135-degree axis if too far). The main return beam from the disc's information layer is used for servo control of focus and tracking, and for data recovery. The actual implementation could use an astigmatic objective lens rather than a separate cylindrical lens to reduce cost, but the effect is the same. Since the objective lens is molded plastic, it costs no more to mold an astigmatic lens (though grinding the original molds might have been a treat!). It is even possible that in some cases, the natural astigmatism of the laser diode itself plays a part in this process.

In essence, the optical pickup is an electronically steered and stabilized microscope that is extracting information from tracks $^1/_{20}$ the width of a human red blood cell while flying along at a linear velocity of 1.2 meters per second!

Now that you know everything (almost) there is to know about how CDs are made and work, we will wind up our theoretical discussion and go on to the good stuff, how to fix a player or a drive when it is broken. Tune in next time for our first CD troubleshooting segment. In the meantime if you have any problems or questions that just can't wait, go to my Web site at www.repairfaq.org. For questions to me, address them to me via e-mail at sam@stdavids.picker.com. (Note: While I would love to answer all your questions, regrettably, the finite number of microseconds in a day prevents me from being able to reply to letters sent via the postal service. However, I will respond to all e-mail requests in a timely manner—usually within 24 hours. Thanks for your understanding in this.)

See you next time. EN

## COMPUTER CONNECTIONS

*continued from page 11*

forming (software) system upgrades;

- Provides instant-on; and
- Returns to previous activity on power-up.

All those things, and some that I've undoubtedly overlooked, are part of the user interface, the overall *gestalt* referred to above. All are things that people like us routinely handle, perhaps because the technical details are (or were initially) interesting to us, perhaps because it's part of our job description, or perhaps because we simply accept it as the price we have to pay to do what we really want to do. But what about the other 99.5% of humanity?

The Pilot doesn't do all the things listed. But it does most, in its small way. So what happens if the Pilot gets bigger, if it scales up, and maintains those attributes? That's why Microsoft is scared. That's why the race isn't over. That's why ideas like NetPCs and network computers are still compelling for some applications. They can present a focused, robust, reliable user interface—if not a universal one.

Microsoft and Intel are seemingly unassailable in their present positions. But Windows so far has failed as a PDA UI, and I have trouble seeing it as a "Toaster-User Interface," either.

1997 may well have been the beginning of the end for Wintel. There are chinks in the armor, some big enough to fly a space shuttle through, and the success of the Pilot shows that new *platforms* can thrive. Believe it or not, it is still possible that the market could eventually just discard Wintel as yet another stepping stone on the way to the future.

I don't think anyone doubts the ubiquity of computer technology in this future. But the precise shape of the technology is still to be determined. I am utterly certain, however, that bloated, slow, confusing, and vulnerable are not going to be attributes of this technology. To the extent that Wintel continues supplying products with those attributes, there is that much more opportunity for innovative new platforms.

Wintel could close the gaps before it's too late. But it may not. Time will tell.

We've closed out our sole-focus tutorial on PalmPilot programming for now. Though we'll be returning to the PalmPilot on occassion, it's time to explore some fresh topics, which we'll begin next time. EN

# World-Wide Radio

THE IC-PCR1000 IS A "BLACK-BOX" communications device that transforms a personal computer into a high-quality wide-band communications receiver. Compatible with many different PC models, even laptops, the PCR-1000 connects to computers externally and offers both "band-scope" functions and exceptional receiver/scanner performance.

The device receives local radio and TV broadcasts, as well as shortwave broadcasts that carry data transmissions, news, music, and events from other countries—such as BBC shows or rugby matches from Australia. In addition, PC users are able to listen to or "scan" public safety (fire, police, search and rescue), commercial, military, aircraft, and marine communications. For mobile reception, it can be used in a car simply by connecting it to a laptop and using the power from a 12-volt cigarette lighter.

Featuring three receiver-interface screens (a communications-receiver screen, a component-type screen, and a radio screen), it works while other programs are in use. There is an unlimited number of memory channels, grouped into banks of 50 channels each that can be stored on either the hard drive or on a floppy. Each memory stores frequency, receive mode, memory names, tuning steps, and attenuator and filter settings.

The size of a small hard-bound novel, this "black-box" receiver covers a wide frequency range from 0.01 to 1300 MHz, with all-mode receive capability, including WFM, FM, AM, SSB, and CW. The IC-PCR1000 has a suggested list price of $599.


CIRCLE 20 ON FREE INFORMATION CARD

**ICOM AMERICA, INC.**
*2380 116th Ave., N.E.*
*P.O. Box C-90029*
*Bellevue, WA 98009-9029*
*Tel: 425-454-8155*
*Fax: 425-454-1509*
*Web: www.icomamerica.com*

# Versatile Tester

A COMPACT, RUGGED, ALL-trade, general-purpose meter, the Model DM7 is designed for basic electronic and electrical troubleshooting, testing, and measurement. Its small size (5.5- × 3.1- × 1.6-inches) makes it practical for portable testing anywhere: for field-service applications or as an easy-to-use meter for around the home, garage, or workshop.


CIRCLE 21 ON FREE INFORMATION CARD

Measurement capabilities of this DMM include AC voltage, DC voltage, DC current, resistance, and battery testing. Features of the DM7 include a 2000-count precision digital readout, AC/DC ranges to 600 volts, DC current to 200mA, four resistance ranges to 2 megohms, diode testing, and a quick battery tester for 1.5- and 9-volt batteries.

The Model DM7 digital multimeter comes with safety test leads and protective holster. It retails for $29.95.

**WAVETEK CORP.**
*9045 Balboa Avenue*
*San Diego, CA 92123*
*Tel: 800-854-2708 or 619-279-2200*
*Fax: 619-565-9558*
*Web: www.wavetek.com*

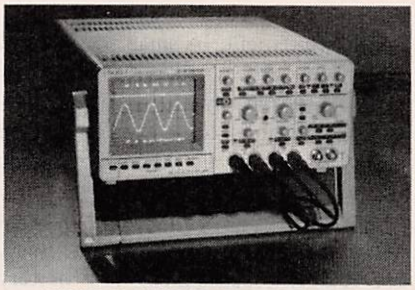
## Differential Oscilloscope

PROVIDING THE BENEFITS OF A full-function analog, digital-storage, and differential oscilloscope, the Model 5034 30MHz Differential Oscilloscope is capable of measuring motor-control circuits, switching power, 3-phase power, and high common-mode voltages. It offers direct viewing of line voltages, safe from the hazards of "hot chassis" equipment.

The 5034 measures small signals superimposed on high AC or DC voltages by using one differential input to reference the common mode voltage. The instrument allows phase analysis of multi-phase systems. In the differential mode, full sensitivity is provided from 10mV/div to 200V/div.

Its dual-channel capability includes functioning as a dual-trace scope in the differential mode with full differential inputs on both channels and external trigger input. Among the features of the 5034 are digital refresh at 0.1µs to 200s/div, 40-MHz sampling frequency, and sweep speed of 0.2µs/div to 200ms/div in 1-2-5 sequence, 20 positions.

An RS-232 port enables hard copy and remote programming. It features 8K memory, autoset, and display cursors/readouts. Compact in size, the unit's 6-inch CRT display offers 8-bit (256-level) resolution. The 5034 is priced at $2330.



CIRCLE 22 ON FREE INFORMATION CARD

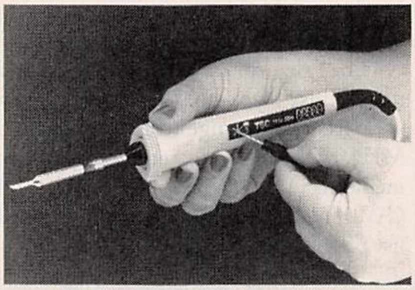
**B+K PRECISION**
*4353 West Lawrence Avenue*
*Chicago, IL 60630*
*Tel: 773-725-9252*
*Fax: 773-725-9385*
*Web: www.bkprecision.com*

## Adjustable Soldering Iron

A COMPLETELY SELF-CONTAINED soldering iron, the Antex Model TCS Temperature-Controlled Soldering Iron features an adjustment screw on the handle for setting tip temperatures to the optimum heat level. The screw, which adjusts using a small screwdriver, can set the temperature from 390°F to 850°F with ±1% stability (typical).

Eliminating the need for a separate soldering station, this standard-size iron has a tapered plastic handle that fits the hand comfortably. It is well-suited for use in electronic assembly and field-service operations.

The Model TCS Soldering Iron has zero-voltage switching, heats up to 650°F in less than a minute, and provides rapid recovery time. A wide selection of slide-on tips is offered. There are two versions available: a 115-volt AC model and one for 24-volt power supplies. The Antex Model TCS Temperature-Controlled Soldering Iron lists for $77.42.



CIRCLE 23 ON FREE INFORMATION CARD

**M.M. NEWMAN CORPORATION**
*24 Tioga Way*
*P.O. Box 615*
*Marblehead, MA 01945*
*Tel: 781-631-7100*
*Fax: 781-631-8887*

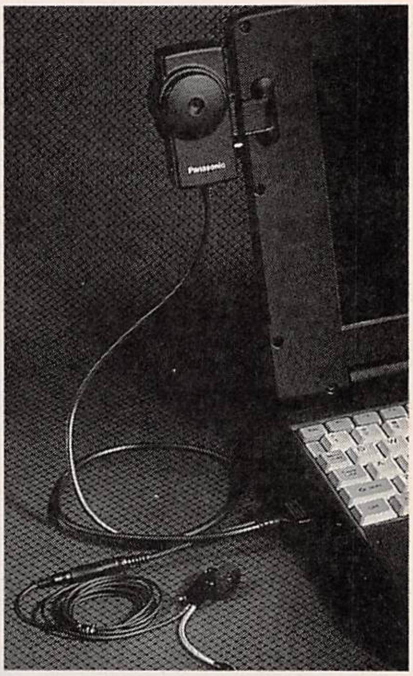
## Clip-On Notebook Video Camera

THIS COLOR VIDEO CAMERA that clips to a notebook's display and plugs into a PC-card slot can be used by laptop owners to create and send video e-mail and for videoconferencing. Unlike other portable cameras in its class, the Panasonic Clip-On Notebook Camera (model PM-S122) offers full-duplex sound for telephone-like audioconferencing.

It is one of the first complete, easy-to-use videoconferencing systems designed for use with a laptop. Both camera and headset connect to an included conference card that plugs directly into any PCMCIA Type II slot. The headset includes earphone and adjustable microphone.

Measuring 3.1 by 1.7 by 1.2 inches, the camera is smaller than a business card. It produces images with a resolution of 542 × 497 and 300 TV lines. When clipped to the left side of a notebook's flip display, the camera swivels up to 40 degrees, and tilts up to 120 degrees, making it easy to frame a subject's face. It includes an automatic gain control and automatic white balance for optimum color fidelity, and has an adjustable-focus lens.

The advanced compression techniques of the bundled software allows PM-S122 users to create and send A/V messages as e-mail attachments. Other included software allows real-time A/V communication between two or more people, via a standard phone line, the Internet, or over a LAN. System requirements are Windows 95 and a minimum of 16MB of memory. The PM-S122 Clip-On carries an estimated street price of $549.




CIRCLE 24 ON FREE INFORMATION CARD

**PANASONIC COMMUNICATIONS & SYSTEMS COMPANY**
*Two Panasonic Way*
*Secaucus, NJ 07094*
*Tel: 800-742-8086 or 201-348-7000*
*Web: www.panasonic.com/alive*

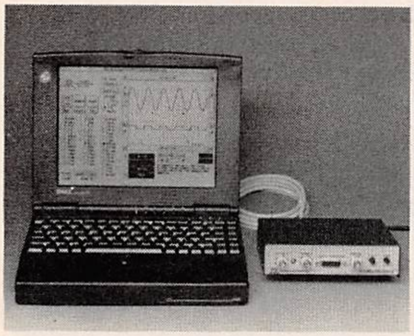
## Virtual Instruments

THE MISSION TECHNOLOGY PC-MultiScope2, from Amaze Electronics, when connected to a personal computer, can replace an entire lab of bench equipment. The device transforms any PC into a full-function digital storage oscilloscope, spectrum analyzer, strip-chart recorder, digital voltmeter, and adjustable DC power supply. With an optional module, it also serves as a function generator.

The PC-MultiScope2 is easy to install

and use. It connects to a PC through the parallel port and has a Windows 3.1/95 user interface. Weighing less than two pounds, it can be used in the lab, at home, or in the field.

The PC-MultiScope2 costs $399.



CIRCLE 25 ON FREE INFORMATION CARD

**AMAZE ELECTRONICS CORPORATION**
*4575 Grimsby Drive*
*San Jose, CA 95130*
*Phone: 800-996-2008*
*Fax: 408-374-1737*
*E-mail: amaze@hooked.net*
*Web: http://www.hooked.net/users/amaze*

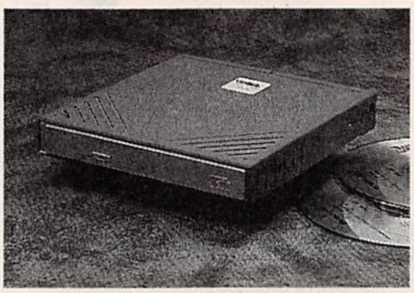
## Pint-Sized 103 CD-ROM Drives

ACCORDING TO ADDONICS Technologies, its PCMCIA PocketCD and Parallel PocketCD portable CD-ROM drives are smaller, lighter, and faster than any other product on the market. Each measures 5.5 by 5.3 by 0.7 inches and weighs 15 ounces. Average access time is 190 ms, average data-transfer rate is 1.5 MB/s (103), and maximum data transfer rate is 1.8 MB/s (123).

In the same space as two standard CD jewel cases, the PCMCIA PocketCD contains a 103-speed CD-ROM drive, internal rechargeable batteries, a PCMCIA interface, a mini-headphone jack, and controls for audio CD playback. The device can be powered from a laptop computer's battery through its PCMCIA interface, through its batteries, or from an external power adapter (sold separately). A parallel interface is also available as an option. Designed for the mobile professional who needs access to his CD-ROM drive everywhere, the PCMCIA PocketCD can also be used as a portable CD player.

The Parallel PocketCD, for people who want portability but primarily use their CD-ROM drive where line power is available, differs from its sibling in its power source and standard interface. This drive comes with an internal compartment for four "AA" batteries, a parallel-port interface, a mini-headphone jack, and controls for audio CD playback. A 5-volt power adapter is included.

The PCMCIA PocketCD and Parallel PocketCD have suggested retail prices of $399 and $349, with expected street prices of $349 and $299, respectively.



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**ADDONICS TECHNOLOGIES**
*48434 Milmont Drive*
*Fremont, CA 94538*
*Tel: 510-438-6530*
*Fax: 510-353-2020*
*E-mail: Atc@addonics.com*
*Web: http://www.addonics.com*

## Digital Triple-Output Power Supply

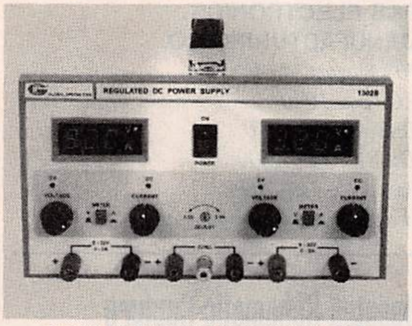
OFFERING DIFFERENT VOLTAGE and current outputs, the Model 1302B Triple Output constant-current /constant-voltage DC Power Supply by Global Specialties is designed for industrial and laboratory use. A fully-regulated power supply, it meets all DC voltage requirements. It is used for product development, analog-and digital-circuit design, product development, testing, quality control, servicing, and education.

The two main outputs are continuously variable from 0 to 32 volts and can each supply 2 amps maximum. They can be operated in constant-voltage or constant-current modes. In addition, a separate 5-volt output provides variable 4.5- to 5.5-volts DC power at 5 amps.

Separate front-panel meters are provided to monitor output voltage and load current for the 32-volt sections. Green LED digital displays make the meters easy to read. Switch selection enables either voltage or current monitoring for each section.

Automatic overload and short-circuit protection is built in. Additional protection is provided by the isolated design of the heavy-duty transformers.

The compact, fully solid-state instrument measures 9 × 11.5 × 5.5 inches, and is priced at $595.

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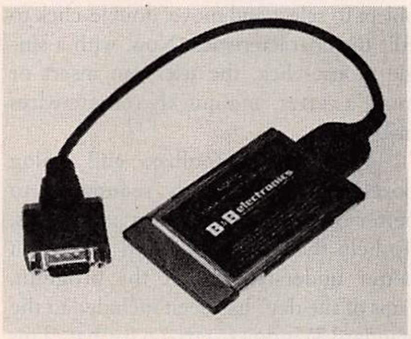
**GLOBAL SPECIALTIES**
*70 Fulton Terrace*
*New Haven, CT 06512*
*Tel: 800-572-1028 or 203-466-6103*
*Fax: 203-468-0060*

## Serial Port for Your Laptop

ADDING B&B ELECTRONICS' 485PCC PCMCIA card to your laptop provides it with an RS-422/485 serial port. This single card can be configured for either an RS-422 orRS-485 port, and for high speed and normal communications.

The Type-II (5 mm) PCMCIA card is ideal for field-service representatives who work on numerous configurations. It features Automatic Send Data control, which handles RS-485 driver enable and disable functions transparently, allowing easy use with Windows 95 and software without RTS support. Users can also set the 485PCC to 4× clock mode, which allows baud rates up to 460.8K. A 16550UART offers high-speed communications with reduced CPU overhead. Pinouts of the 485 match the SMPTE video standard for controlling devices.




CIRCLE 28 ON FREE INFORMATION CARD

A simple configuration program is shipped with the card, and configuration options are stored in non-volatile memory. The 12-inch cable included with the card has a D89 male connector. The 485PCC PCMIA Serial Port Card is priced at $159.95

**B&B ELECTRONICS MANUFACTURING CO.**
*707 Dayton Road*
*P.O. Box 1040*
*Ottawa, IL 61350*
*Tel: 815-433-5100*
*Fax: 815-434-7094*
*Web: http://www.bb-elec.com*

## Updated Schematic-Capture Software

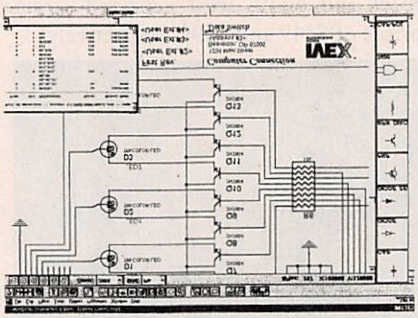
VERSION 2.0 OF WINDRAFT Schematic Capture software from Ivex Design International features a new "Parts Palette" that allows the user to select up to 20 frequently used parts. The Palette appears on the screen next to the worksheet, where the user can just click on a part and then click on the sheet to place it. The user can scroll through the Palette with the standard Windows scroll bar. Parts can be easily added or deleted from the Palette. The user can even customize the order of the parts after they have been placed in the Palette.

Another new feature is the ability to import BMP graphic files, which can now be used to customize the title block with a logo or to import other graphic designs onto a worksheet. True-type fonts have been added throughout the program, including title block, pin numbers, references, values, and hierarchical sheet symbols. In past versions of WinDraft, true-type fonts were available only on comment text.

Editing functions have been revised to be more natural and to conform to the format used with the Ivex WinBoard PCB layout program. Single-click on an object to select and move; double-click to edit the characteristics. Now, with a single mouse-click, the user can insert or move a vertex, and quickly reroute wires or buses.

WinDraft 2.0 toolbars and dialog boxes have been totally redesigned to better organize information and setups. To help the less experienced user get a better understanding of the program, "tips of the day" has been included in the standard Windows start-up format. Tips include answers to the most frequently asked questions about the product and shortcuts to commands.

The unlimited pin capacity version of WinDraft 2.0 costs $495, and the 650-pin version costs $240. Registered customers will be notified as to the upgrade cost. A free shareware version of either WinDraft or WinBoard can be obtained from the Web site listed below. The shareware versions are complete, fully-functional programs with a 100-pin/pad limitation and can be used to view any size design.



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**IVEX DESIGN INTERNATIONAL**
*15232 NW Greenbrier Parkway*
*Beaverton, OR 97006-5746*
*Tel: 503-531-3555*
*Fax: 503-629-4907*
*E-mail: info@ivex.com*
*Web: http://www.ivex.com.*

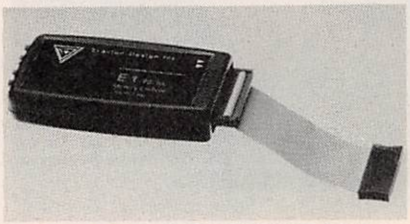
## Memory Emulators

OFFERING ENHANCED FEATURES, Scanlon Design Inc.'s E-Series emulates EPROM, FLASH, ROM, and static RAM memory devices from 8K×8–128K×8 (E1) to 8K×8–1024K×8 (E8). Live editing, live watches, and advanced debugging are featured in the emulators. The software lets the user see SRAM variables change and allows the editing of run-time data to force conditions and fully test embedded systems.

All the models provide reading and writing at full speed and simultaneous live viewing and editing from the host PC. Software debugging features such as memory-mapped bi-directional communication and third-party remote-debugger support allow the target system to pass debugging information back to the host PC. The E-Series also offers error checking and correction while downloading (420 kbps), has an access time of 70 ns, and draws a maximum current of only 5 mA from the target system,

These products feature simple hookup and connection for up to four emulators, multiple output signals for control of the target system, and memory backup for power-up emulation. Each emulator comes with 28- and 32-pin DIP adapters. Also available are 32-pin PLCC adapters, as well as low-voltage models that allow operation from 2.7 to 5.5V.

The E-Series emulators are priced from $199 for the E1-70 to $369 for the E8LV-90.



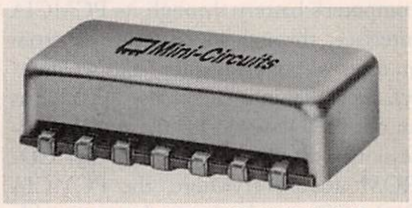
CIRCLE 30 ON FREE INFORMATION CARD

**SCANLON DESIGN INC.**
*5224 Blowers Street*
*Halifax, N. S.*
*Canada B3J 1J7*
*Tel: 800-352-9770 or 902-425-3938*
*Fax: 902-425-4098*
*E-mail: info@scanlondesign.com*
*Web: www. scanlondesign.com*

## Wide-Band VCO

MINI-CIRCUITS' JTOS-1025 WIDE-band VCO is a low-cost surface-mount, voltage-controlled oscillator. This high-performance VCO features a wide range of linear tuning (685–1025 MHz) , -28 dBc harmonic suppression, and low -70 dBc/Hz SSB phase noise at 1 kHz offset (typical). Tuning voltage is 1-16 volts (absolute maximum is 20 volts).

This VCO is housed in a rugged metal case with solder-plated J leads for superior mechanical integrity. Uses include measurement instrumentation and PLL circuitry applications. The JTOS-1025 is priced at $18.95 each (quantity 5-49), with immediate off-the-shelf availability.

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**MINI-CIRCUITS**
*P.O. Box 350166*
*Brooklyn, NY 11235-0003*
*Tel: 718-934-4500*
*Fax: 718-332-4661*
*Web: http://www.minicircuits.com*

# NEW LITERATURE

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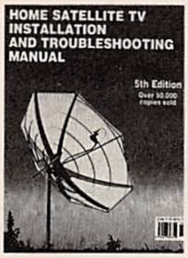
## Home Satellite TV Installation and Troubleshooting Manual 5th Edition

*by Frank Baylin with Brent Gale and Ron Long*
*Baylin Publications*
*1905 Mariposa Blvd.*
*Boulder, CO 80302*
*Tel: 800-483-2423*
*Web: www.baylin.com*
**$30 plus $4 S & H**




CIRCLE 338 ON FREE INFORMATION CARD

Written in a style that can be easily understood by an interested layman, this 326-page manual is an invaluable working tool designed to make selecting, installing, and maintaining large-dish satellite systems easy. Largely rewritten and re-organized, this fifth edition of the book contains over 300 up-to-date illustrations, photographs, and tables, and includes background theory and details on how satellites and TVROs operate, as well as methods to select and judge satellite TV components.

There is a detailed step-by-step installation and dish-aiming guide with all the necessary charts and tables, thorough diagrams and text explaining conventional and IF multiple-receiver and multiple-television hookups, and methods to install unusually large dishes. In addition, readers are shown a complete strategy and details on troubleshooting any satellite TV system.

Complete explanations of the MPEG-2 digital television standard, video compression methods, IF distribution of satellite signals, and a brief overview of digital link analysis are presented. The appendix includes a useful collection of equations, a glossary, and a complete list of satellite equipment manufacturers, as well as reference books and magazines.

## 1998 Test & Measurement Accessories Catalog

*ITT Pomona Electronics*
*1500 E. 9th Street*
*Pomona, CA 91766-3835*
*Tel: 909-469-2900*
*Fax: 909-629-3317*
*Web: www.ittpomona.com*
**Free**


CIRCLE 339 ON FREE INFORMATION CARD

This 50th anniversary catalog presents the full line of Pomona test and measurement accessories. A complete range of coaxial cable assemblies and adapters, patch cords, enclosures and boxes, IC test clips for 2- and 4-sided devices, and static control products are among the items included in the 92-page catalog.

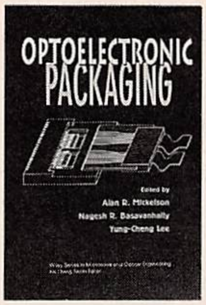
Highlighted are newly designed DMM accessories, a new family of high-performance oscilloscope probes, and the first IEC1010-compliant mini-grabber ever offered. The redesigned DMM accessories are featured in ITT Pomona's Test Companion Kits, which are compatible with Fluke, Hewlett-Packard, Tektronix, and Wavetek DMMs and oscilloscopes. The mini-grabber's slim-line design allows easier access with today's more-densely populated test situations. It is paired with a right-angle plug, a straight plug, a banana jack, a multi-stacking banana plug, or another mini-grabber to create eight distinct patch cords.

Also featured are ×1/×10 Passive Oscilloscope Probes offering dual-bandwidth performance for greater text flexibility, a $^{7}/_{16}$ DIN Adapter Kit improving intermodulation performance, and a push-on BNC 50-ohm cable.



## Optoelectonic Packaging

*Edited by Alan R. Mickelson, Nagesh R. Basavanhally, and Yung-Cheng Lee*
*John Wiley and Sons, Inc.*
*605 Third Avenue*
*New York, NY 10158-0012*
*Tel: 212-850-6336*
**$74.95**




CIRCLE 340 ON FREE INFORMATION CARD

The rapidly expanding field of packaging for optoelectronic devices presents the engineer with complicated problems to solve. One major challenge is how to assemble an array with many elements efficiently, while maintaining thermal tolerance and simultaneously overcoming electrical-noise problems. Designed for professionals in the field, *Optoelectronic Packaging* is the first source book available on optoelectronic-assembly techniques.

The book provides an overview of current state-of-the-art technologies, packages that are now on the drawing board, and the future direction of packaging. It also explains the fundamentals of optics and packaging.

Featuring contributions from expert practitioners in the field and numerous illustrations, the text covers the subject of assembly technologies. It explains detector, semiconductor laser, and optical-amplifier packaging. Waveguide and hybrid technologies are discussed. The book also examines communication-system interconnection structure and fiber-optic networks in telecommunications. Case studies of packaged subassemblies are also included.

## Bigelow's Computer Repair Toolkit

*by Stephen J. Bigelow*
*McGraw-Hill*
*11 West 19th Street*
*New York, NY 10011*
*Tel: 800-2MCGRAW*
**$39.95**


CIRCLE 341 ON FREE INFORMATION CARD

This book is the first to bring together over 100 shareware and public-domain diagnostics and utilities on a single disk: the DLS Diagnostic CD (included with the book). The book and CD combine to give technicians a "Swiss army knife" of tools to aid in troubleshooting or upgrading computers.

Divided into nine chapters, the book explains why, when, and how to use these diagnostic programs. The first chapter gives an overview of the shareware. The subsequent six chapters give highlights of the programs: general PC hardware tools, video systems, printers and parallel-port tools, modem and communications tools, drive tools, and general support tools. The last two chapters discuss the commercial diagnostics included on the CD.

## 1997 Technical Library, 2nd Edition

*Microchip Technology, Inc.*
*2355 W. Chandler Blvd.*
*Chandler, AZ 85224-6199*
*Tel: 602-786-7668*
*Web: www.microchip.com*
**Free**

CIRCLE 342 ON FREE INFORMATION CARD

This CD-ROM contains technical literature on Microchip's PICmicro 8-bit RISC-based microcontrollers, non-volatile memory devices, ASSPs, secure data products, and associated development tools. Included are: the *In-Circuit Serial Programming Guide*, application notes, data sheets, third-party guide, development-systems software, users' guides, packaging diagrams and parameters, and worldwide sales and service information.

Microchip products target thousands of embedded control applications in the consumer, automotive, office automation, communications, and industrial markets.

## Beginner's Guide to Tube Audio Design

*by Bruce Rozenblit*
*Audio Amateur Corporation*
*Old Colony Sound Laboratory*
*P.O. Box 243*
*Peterborough, NH 03458-0243*
**$24.95**


CIRCLE 343 ON FREE INFORMATION CARD

This beginner's guide describes what vacuum tubes do and how to use them. It shows readers how to design the building blocks that turn tubes, transformers, and other hardware into amplifiers.

After beginning with tube basics, the author then goes on to explain their characteristics and how to read charts and specifications. In a systematic manner, a complete explanation of audio design is provided for more advanced readers—from single one-stage amplifiers to multistage basics and variations such as triode and ultralinear operation. Complete instructions for building three working projects are provided at the end of the book.

Other chapters cover a simple-gain circuit; negative feedback and how to use it; power sources for the amplifiers, how they work, and how to build them; stabilization and testing; and a description of 13 classic amps and pre-amps. There are also tips on working effectively as a designer, construction techniques, and choosing tools and components.

## Passive Electronic Component Handbook: 2nd Edition

*Edited by Charles A. Harper*
*McGraw-Hill, Inc.*
*11 West 19th Street*
*New York, NY 10011*
*Tel: 800-2MCGRAW or 212-337-5951*
*Fax: 212-337-4091*
*Web: www.ee.mcgraw-hill.com*
**$89.50**


CIRCLE 344 ON FREE INFORMATION CARD

The fully updated and revised edition of this comprehensive standard reference on passive electronic components is the first one in fifteen years. The revision, written by experts in the field, gives quick, reliable, one-volume access to critical characteristic data, performance curves, and design guidelines. (A companion volume covers active components.)

The full range of component technologies is covered, including resistors, capacitors, transformers, relays and switches, batteries, fuse and protective components, filters and transient voltage-protection devices, wiring and cabling, and connectors and cabling devices. The source book also offers test and reliability data; listings of specifications and standards; and information on dimensions, configuration, and mechanical and functional performance.

The 786-page handbook provides engineers, designers, and technicians with the practical data needed to more effectively select optimal components in virtually any electronics system.

## Mobile Data & Wireless LAN Technologies

*by Rifaat A. Dayem*
*Prentice Hall*
*One Lake Street*
*Upper Saddle River, NJ 07458*
*Tel: 800-382-3419*
*Web: www.prenhall.com*
**$55**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Designed for engineers, networking professionals, and mangers, this is a state-of-the-art guide to where wireless data stands now and what to expect tomorrow. It presents detailed technical and business information for every leading and emerging wireless LAN and WAN technology,

The author reviews potential applications, market forecasts, and key players. Technologies covered include spread spectrum, packet radio, infrared, CDPD, two-way paging, and MAC protocols for wireless networks. Other technologies discussed are mobile IP, 802.11, Hyperlan, wireless ATM, and data-over-circuit-switched solutions. In addition, there is a primer on wireless networking, and information on mobile data, wireless spectra, and international standards.

## FrontPage 97 Sourcebook

*by Wayne F. Brooks*
*John Wiley & Sons, Inc.*
*605 Third Avenue*
*New York, NY 10158-0012*
*Tel: 800-225-5945*
*Web: www.wiley.com/compbooks/*
**$29.95**


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FrontPage 97 lets you combine graphics, text, audio, and video in your web documents without having to use HTML. With this comprehensive guide to both FrontPage 97 and ActiveX controls, readers can learn all about creating, publishing, and managing Web pages.

From creating the FrontPage 97 working environment, the book progresses to activating a Web site and working with texts, multimedia, links, tables and frames, forms, and templates and wizards. Enhancing the Web site with ActiveX controls and supporting Java, VBScript, and Netscape plug-ins are fully explained. Instruction is included on preparing, hosting, posting, and maintaining the Web site.

## Designer's Guide to Flat-Panel Systems for the OEM and Industrial User

*Computer Dynamics*
*7640 Pelham Road*
*Greenville, SC 29615*
*Tel: 864-627-8800*
*Fax: 864-675-0106*
*E-mail: sales@.cdynamics.com*
*Web: www.cdynamics.com*
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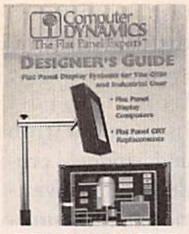


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display solutions is presented in this catalog: complete flat-panel computers, plug-in flat-panel CRT replacements, the latest displays (XGA, SVGA, and VGA resolutions, with sizes ranging from 6.4-inches to 17.7 inches), and an extensive touchscreen selection. Also included are product selection guides, design tips, and complete information on Computer Dynamics PC-compatible single-board computers.



Numerous custom configuration options are given for each of the 22 displays shown. The guide features Computer Dynamics' major float-panel displays: Display Pac, VAMP, and the FP-Kit, as well as the new Ultra-Brites. Also included in The Designer's Guide are new enclosures and mounting options for flat-panel display systems, information

on software development tools for touch-screen implementation, and PC/104 expansion boards. All the flat-panel systems are accompanied by mechanical drawings.

## Java Security: Hostile Applets, Holes, and Antidotes

*by Gary McGraw and Edward W. Felten*
*John Wiley & Sons, Inc.*
*605 Third Avenue*
*New York, NY 10158*
*Tel: 212-850-6336*
*Web: http://www.wiley.com/compbooks*
**$19.95**


CIRCLE 348 ON FREE INFORMATION CARD

Do you know how to sort out fact from fiction when it comes to Java security? Did you know that whenever you surf the Web with Netscape or use Internet Explorer you are using Java? That means that someone else's code is running untested on your computer. Your site could be vulnerable to a hostile applet or other security problem.

Written by international security experts, this book tells you how Java security works and how it doesn't. Geared to webmasters or information-technology managers, it contains all the information needed to create a strategy for Java use. Included are guidelines for using Java more safely, the future of Java security, as well as explanations of the risks of using Java. The authors also explain the three prongs of the Java security model: Byte Code Verifier, Applet Class Loader, and the Security Manager; and discuss the holes in that model.

## 1997/1998 Measurement Products Catalog

*Tektronix, Inc.*
*P.O. Box1520*
*Pittsfield, MA 01202*
*Tel: 800-426-2200 (Press 3, Code 1040)*
*Web: www.tek.com/Measurement*
**Free**

Available worldwide, this publication is aimed at design engineers and professionals in the manufacturing, service, communications, and television testing fields. It includes a broad offering of

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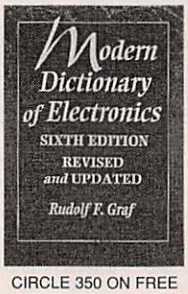
test equipment: instrumentation solutions range from low-cost instrumentation and handheld products to conventional measurement products and advanced mixed-signal test solutions.

Throughout, the catalog highlights products manufactured in the company's ISO-9001-certified facilities. In addition to its detailed product descriptions, the catalog lists Tektronix tutorials, and application and technical notes. Extensive indexes arrange products by name and by function, as well as by categories such as oscilloscopes, logic analyzers, VXI systems, telecommunications, and television test.

The 630-page, soft-cover catalog contains a full-color, new product section featuring 80 new products and measurement solutions. This is the first Tektronix catalog to use advanced computer-to-plate printing technology that provides much more detail in product photos than did previous versions.

## Modern Dictionary of Electronics, 6th Edition

*by Rudolf F. Graf*
*Newnes, Butterworth-Heinemann*
*225 Wildwood Avenue, Unit B*
*P.O. Box 4500*
*Woburn, MA 01801-2041*
*Tel: 617-928-2500*
*Fax: 617-933-6333*
*Web: www.bh.com/bh*
**$49.95**




CIRCLE 350 ON FREE INFORMATION CARD

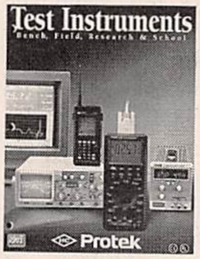
With over 25,000 electronics terms and hundreds of illustrations, this revised edition includes 5000 more definitions than were in the previous one. In addition, all the previously published terms were updated and revised, where necessary. Definitions are written in a clear and simple style, consistent with the complexity level of the term being defined.

The dictionary covers special topics, such as audio electronics, television and video, computers, fiber optics, microelectronics, communications, industrial processes, and medical electronics. Abbreviations and acronyms are given, and there are tables of SI units and schematic symbols.



## Test Instruments Catalog

*HC Protek, Inc.*
*154 Veterans Drive*
*Northvale, NJ 07647*
*Tel: 201-767-7242*
*Fax: 201-767-7343*
*E-mail: hcprotek@aol.com*
*Web: www.techexpo.com/www/hcprotek*
**Free**




CIRCLE 351 ON FREE INFORMATION CARD

A series of newly developed test instruments—RF generators, AC millivolt meters, portable power supplies, digital multimeters, and analog meters—are among a number of cost-effective, high-reliability products featured here. Some of the new products highlighted in this edition are audio generators such as the B-850, the A800-series of VOMs, and a group of 30xx power supplies.

This 52-page publication details more than 75 instruments. It incorporates quick reference guides for selecting digital and analog products, including digital storage scopes, portable and bench-type scopes, state-of-the-art DMMs, and other instruments. The catalog also provides comprehensive specifications data for all products, along with cross-reference indexing for easy identification. Black and white photos accompany each product description. EN

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4401 CONNECTICUT AVENUE NW
WASHINGTON DC 20078-3543

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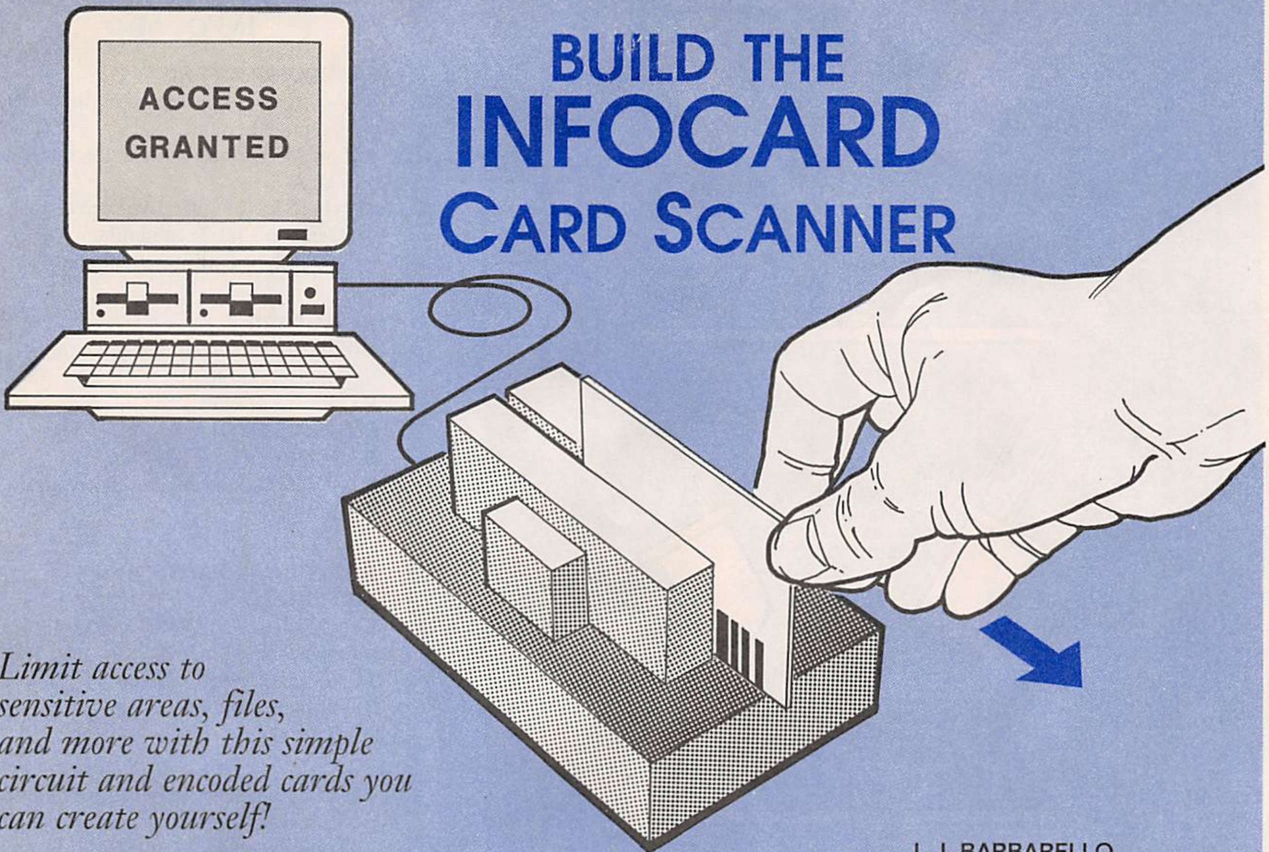



*Limit access to sensitive areas, files, and more with this simple circuit and encoded cards you can create yourself!*

J. J. BARBARELLO

Reflective-optical sensors are non-contact devices that use a light source and a photo-sensitive detector to detect the presence or absence of a reflective surface. To sense that type of surface, the source and detector are positioned so the light hits the surface at an angle; the reflected light is then seen by the detector. Infrared (IR) sensors produce better results than visible light sensors because IR energy in the 900-nanometer range is not normally present in large amounts in visible light. An IR sensor can be used easily where ambient light might cause false triggering of a visible-light detector.

A "reflective surface" might lead you to think of a surface such as a mirror that's either present (reflective) or absent (non-reflective). However, while paper is a good reflector of infrared light, many different types of inks (and the graphite in a lead pencil) do *not* reflect IR energy very much. With the right type of ink, we can use a reflective IR optical sensor to make a device that reads a series of different width bars separated from each other by a white space on a card. One such bar pattern is the Universal Product Code, or UPC—otherwise known as "bar" codes. However, such a code is not limited to the UPC standard. For example, we can use a basic binary code instead. A system with simple wide and narrow bars to code the ones and zeros in a binary code results in a bar code that is easy to sense and can have up to 32,767 possibilities with only 15 bars.

The InfoCard project presented here uses a low-cost reflective-IR optical sensor and a simple interface circuit to create an electronic identification system using any PC. One such use of the InfoCard is for coded-entry access by reading a card and energizing an electric door latch for authorized codes. If you are good at programming PIC chips or Basic Stamp devices, you can readily adapt the InfoCard's Basic software routines to use the reader as a stand-alone device.

The swipe cards themselves can be made quickly and cheaply from almost any available paper stock. Best of all, the project cost is about \$10–\$15, depending on the parts you might already have on hand.

**Design Considerations.** To find out how far a reflective surface has to be from the sensor in order to see the most reflected light, we can use the law of optics that says that when light hits a surface at an angle, the angle at which it hits the surface (the *angle of incidence*) is equal to the angle at which it is reflected (the *angle of reflection*). That is shown in Fig. 1A.

As you can see, the reflecting surface is at the perfect distance from the light source and sensor to pick up the greatest amount of reflected light. If the surface is closer or farther away, the amount of energy that the sensor can detect

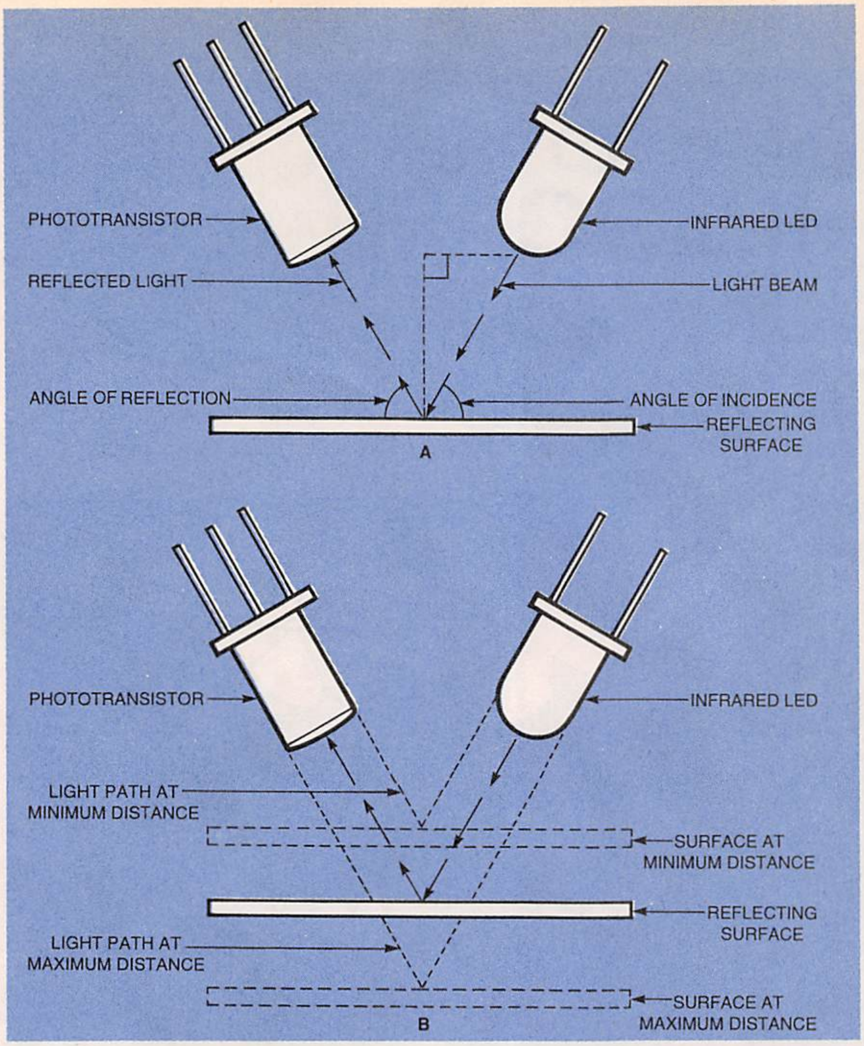



*Fig. 1. If a light beam strikes a reflective surface at an angle, it will bounce off at a "mirror-image" angle (A). For best sensing, the surface must be within the area that the light source and detector are focused on (B). If the surface is too close or too far away, the light will not hit the detector.*

## PARTS LIST FOR THE INFOCARD

**SEMICONDUCTORS**

IC1—78L05 5-volt regulator, low-power, integrated circuit
IC2—LM339 quad comparator, integrated circuit
SEN1–1STS708 reflective optical switch (Jameco 138093 or similar)
LED1—Light-emitting diode, red

**RESISTORS**

(All units are ¼-watt, 5% units unless otherwise noted.)
R1, R5—220-ohm
R2, R8—22,000-ohm
R3, R4, R6, R9—2200-ohm
R7—10,000-ohm potentiometer, multi-turn

**ADDITIONAL PARTS AND MATERIALS**

C1, C2—1µF, 16-WVDC, electrolytic capacitor
J1—DB25 connector, male
9-volt battery, battery connector, hardware, etc.

**NOTE:** Enhanced software, part number ICARD-S (both source and executable code) is available for $12.00 from: James J. Barbarello, 817 Tennent Road, Manalapan, NJ 07726. In addition, the author will be happy to answer any questions sent to the adress above (please include a self-addressed, stamped envelope).

will drop off. That is shown in Fig. 1B. If the reflecting surface is too close or too far, the reflected light will miss the sensor completely. Based on the specifications of the reflective sensor we want to use, we can apply simple trigonometry formulas to find the perfect distance from the sensor to the reflective surface. For the device called for, that distance works out to about $^5/_{32}$ inch.

But we shouldn't stop at just the optimum distance; we should also find the minimum and maximum distances. Again, using basic trigonometry, we find that the surface should not vary more than $^1/_{32}$ inch in either direction from the $^5/_{32}$-inch distance. With those numbers, the card guide that we design should keep the card between $^1/_8$ inch and $^3/_{16}$ inch from the sensor.

One more piece of information to keep in mind when working with light has to do with the tendency of light to disperse from its source. An example of that can be seen in Fig 2A. The width of the beam will affect how narrow a barcode stripe can be seen. By adding an aperture as shown in Fig. 2B, the resolution improves. The width of the aperture must be large enough to allow enough light to be reflected back, but small enough to obtain the desired resolution. The InfoCard will be using a $^1/_{16}$-inch-wide aperture. That will let us space the bars on the card $^1/_{16}$ inch apart.

**Circuit Description.** As you can see in the schematic diagram shown in Fig. 3, the interface circuit for the InfoCard is quite simple and straightforward. Reflective IR sensor SEN1 contains a matched IR diode and an IR detector in a single case. The current for the IR diode is limited by R1; R2 is a pull-up resistor for the collector of the detector. That lets a proper voltage level always be present at the positive input of IC2-b. The negative input is connected to an adjustable voltage divider made up of R3, R7, and R8. By varying R7, the voltage level at which the comparator switches can be set.

When the positive input of IC2-b is less than the negative input, the output will be grounded. That occurs when a reflecting surface is close enough to SEN1 to reflect IR light onto the detector. Otherwise, the output will have no voltage on it. The LM339 was designed that way so that the output could be used in circuits that needed the output level to be different than the supply voltage. Because of that, R4 is used to pull up the output of IC2-b when the output should be high. That signal is connected to pin 11 of the PC's printer port.

A second comparator in IC2 is used as an LED driver. When pin 2 of

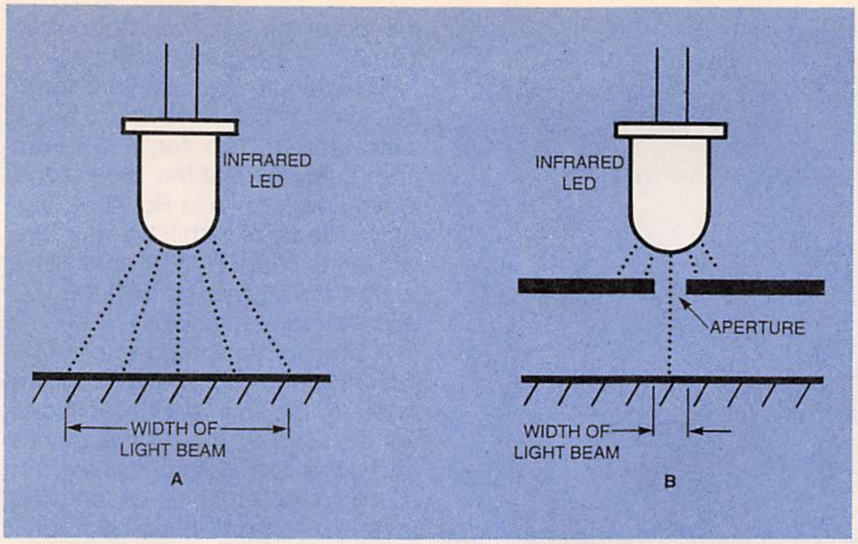



*Fig. 2. Even laser light spreads out as it leaves the source (A). That spreading is called* divergence. *If the spreading light is blocked by an aperture (B), the light beam will have a greater pinpoint accuracy.*

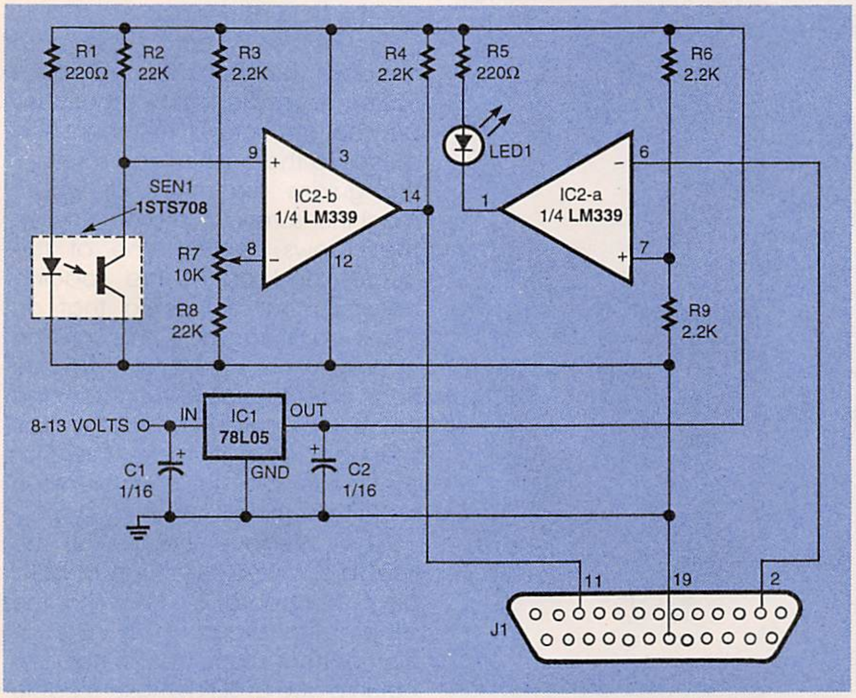



*Fig. 3. The InfoCard's circuit is built around a reflective optical sensor (SEN1) and a comparator (IC1).*

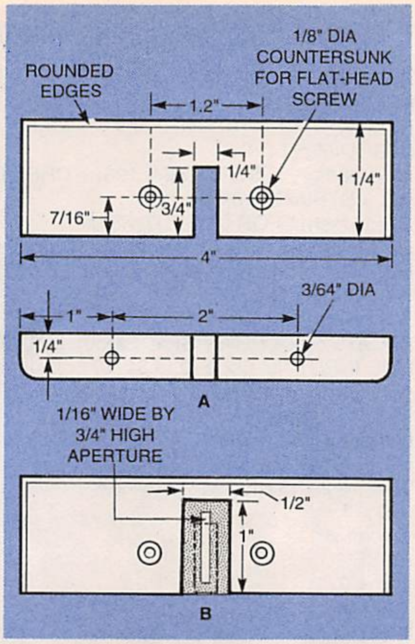



*Fig. 4. The card guides need a slot in one of them to mount the sensor. Use flat-head screws to mount the sensor so that the guide slot will be smooth.*

the parallel port is brought high, IC2-a's output will be open, turning off LED1. A low input to IC2-a will ground its output, letting current flow through R5 and LED1, turning it on. Voltage-divider string R6 and R9 set a switching level for IC2-a that is compatible with the voltage levels present on the parallel port.

Power from any suitable voltage source between 8 and 13 volts is regulated to 5 volts by IC1, with C1 and C2 providing filtering.

**Construction.** The construction details presented here are only for purposes of building an InfoCard demonstrator. Once you are familiar with the design and operation of the unit, no doubt you'll be designing your own custom housings and installations. To begin, we'll start with the card guides.

The dimensions of the card guides are shown in Fig. 4. Use two pieces of ½-inch-thick wood or metal with the dimensions shown in Fig 4A. Both pieces should have their edges rounded as shown. Keep in mind, however, that the rounding shown is greatly exaggerated. It is important that the edges be smooth so that a swipe card will not hang up or tear as it is slid through the guide. The edges that will be rounded will be facing each other to form the guide.

Both guides will have holes drilled in their bottom edge as shown. If you are using metal for the guides, you will have to tap threads into the holes. Once that is done, set one piece aside—it is finished. The second piece will have a notch cut in it as shown for SEN1. The countersunk holes will be used to mount SEN1; the countersink goes on the inside of the guide. The holes should be sized to fit a 4-40 flathead screw.

Install a pair of flathead screws in the countersunk holes with nuts. A second pair of nuts should then be threaded onto the protruding screw threads. Take a piece of perfboard that is large enough to mount SEN1 and drill two holes to match the spacing of the flathead screws. Mount SEN1 on the perfboard. That assembly is then mounted on the screws and held in place with an additional pair of nuts. The second and third nuts will form a "sandwich" that will hold SEN1 in position. Adjust the position of the nuts so that the front of SEN1 is perpendicular to the

**LISTING 1**

```
REM** INFOCARD.BAS
REM** V970719
REM**
CLS : DIM n(14)
x$ = "##### " + STRING$(4, 196) + CHR$(62) + CHR$(32) + CHR$(179)
sp$ = STRING$(10, 32)
OPEN "scrn:" FOR OUTPUT AS #1
LOCATE 1, 27: PRINT "PcInfoCard Card Generator"
LOCATE 2, 1: PRINT STRING$(80, 220);
'PROGRAM BEGINS
getnumber:
LOCATE 5, 27: PRINT SPACE$(50): LOCATE 5, 27
LINE INPUT "ID Code (0 to 32767): "; number$
 IF LEN(number$) = 0 THEN number$ = "0"
 IF VAL(number$) < 0 OR VAL(number$) > 32767 THEN BEEP: GOTO getnumber
number = VAL(number$): n = number: code$ = ""
FOR i = 14 TO 0 STEP -1
 IF n >= 2 ^ i THEN
 n(i) = 1
 n = n - 2 ^ i
 ELSE
 n(i) = 0
 END IF
NEXT i
FOR i = 14 TO 0 STEP -1
 IF n(i) = 1 THEN
 code$ = code$ + CHR$(219) + CHR$(221)
 ELSE
 code$ = code$ + CHR$(221)
 END IF
NEXT i
code$ = code$ + CHR$(222)
code = LEN(code$): delta = 34 - code
IF delta / 2 <> INT(delta / 2) THEN
 d1 = INT(delta / 2): d2 = INT(delta / 2) + 1
ELSE
 d1 = delta / 2: d2 = d1
END IF
LOCATE 7, 1
CLOSE : OPEN "scrn:" FOR OUTPUT AS #1: GOSUB card
LOCATE 5, 27: PRINT SPACE$(50)
LOCATE 8, 52: PRINT "Press"
LOCATE 9, 52: PRINT "——"
LOCATE 11, 52: PRINT "<H> for Hardcopy"
LOCATE 13, 52: PRINT "<Esc> to End"
LOCATE 15, 52: PRINT "Any Other Key to Try Again"
getoption:
a$ = INKEY$: IF a$ = "" THEN GOTO getoption
a$ = UCASE$(a$)
SELECT CASE a$
 CASE IS = CHR$(27)
 CLS : LOCATE 18, 1: END
 CASE IS = "H"
 CLOSE : OPEN "lpt1:" FOR OUTPUT AS #1: GOSUB card
END SELECT
FOR i = 8 TO 15
 LOCATE i, 52: PRINT SPACE$(26)
NEXT i
GOTO getnumber
'
'SUBROUTINE TO PRINT/DISPLAY CARD
card:
PRINT #1, sp$; CHR$(218); STRING$(code + delta, 196); CHR$(191)
FOR i = 1 TO 7
 PRINT #1, sp$; CHR$(179); STRING$(code + delta, 32); CHR$(179)
NEXT i
PRINT #1, sp$; CHR$(179); STRING$(22, 32);
PRINT #1, USING x$; number
FOR i = 1 TO 3:
 PRINT #1, sp$; CHR$(179); STRING$(d1, 32); code$; STRING$(d2, 32); CHR$(179)
NEXT i
PRINT #1, sp$; CHR$(192); STRING$(code + delta, 196); CHR$(217)
RETURN
```

surface of the guide and about 1/8 inch below the guide's surface.

An aperture is made from some black electrical tape or a black write-protect tab for a 5¼-inch computer disk. Cut the tape to the dimensions shown in Fig. 4B. A 1/16-inch wide by ¾-inch long slit is also cut in the tape. Place it over SEN1 so that the slit lines up with the LED and the detector in SEN1.

A base plate is made from 1/8 -inch hardboard or metal as shown in Fig. 5. The four elongated holes will be used to mount the guides and adjust the width of the slot. The 1/8 -inch diameter hole will be used for the wires that will connect SEN1 to the circuit board. If you wish to use a rubber grommet, you should size the hole as needed.

Mount the two card guides onto the base with their rounded edges facing towards each other. Use appropriate screws to mount the guides to the base (wood screws if the guides are made of wood; machine screws if metal). Loosen the screws holding one of the guides and adjust the spacing between the guides so that an index card can pass through the opening with ease, but not move from side to side. Re-tighten the guide in place and check the fit of the index card to make sure that the guide did not shift or move while tightening it down.

The interface circuit for the InfoCard is simple enough to build on a perfboard by following the schematic diagram in Fig. 3. Component placement is not critical. In place of SEN1, make a cable from three equal lengths of insulated wire that will be able to reach from the board to SEN1. Make note of which wires will be connected to the various pins on SEN1.

A second three-wire cable will be used to connect the InfoCard to the PC. Again, three equal lengths of 22- or 24-gauge stranded wire are used. Connect them to pins 2, 11, and 19 of a 25-pin connector. The other ends of the wires connected to pins 2, 11, and 19 are connected to the circuit according to Fig. 3.

Thread the three-wire cable for SEN1 through the hole in the base plate and connect the wires to SEN1. If you are not sure which

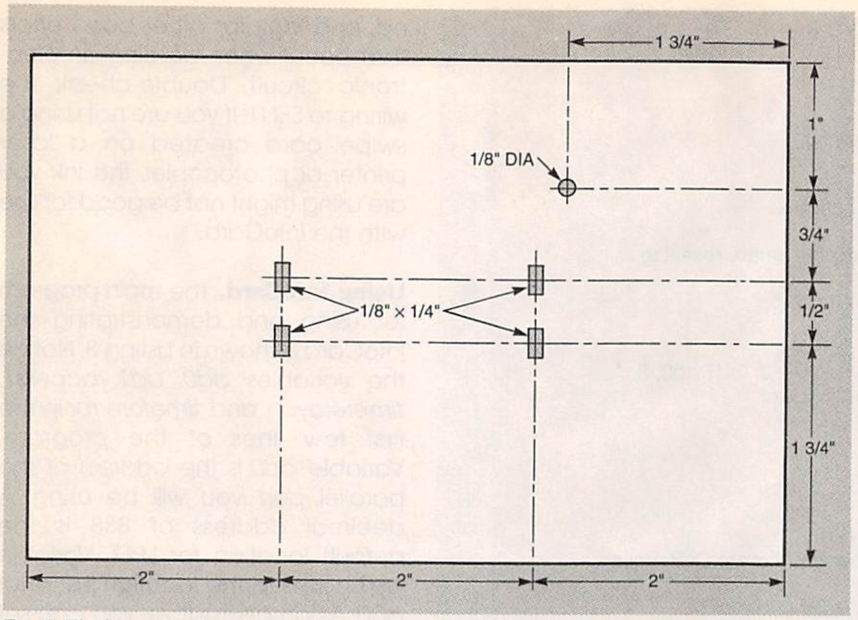



*Fig. 5. The base plate has elongated slots so that the width of the card guide can be adjusted. The wires from the sensor pass through the hole in the upper corner. If you are going to use metal for the base plate, make that hole a bit larger and use a rubber grommet to protect the wires.*

**LISTING 2**

```
''' ICARDTST.BAS
''' Version 970715.1
CLS : DEF SEG = 64: ad0 = 888: ad1 = 889
OUT ad0, 2
PLAY "l64t240"
LOCATE 1, 1
COLOR 0, 7: FOR I = 1 TO 3: PRINT SPACE$(80); : NEXT i
LOCATE 2, 22
PRINT "PcInfoCard Test (Press <Esc> to End)"; : COLOR 7, 0
LOCATE 10, 25: PRINT "Emitter "; STRING$(3, 219); ") \"
LOCATE 11, 40: PRINT "\"
LOCATE 12, 42: PRINT "\"
LOCATE 15, 24: PRINT "Detector "; STRING$(3, 219); ")"
loop00:
a = INP(ad1) AND 128
 IF a = 0 THEN
 OUT ad0, (INP(ad0) AND 254)
 FOR i = 10 TO 15: LOCATE i, 43: PRINT CHR$(32): NEXT i
 LOCATE 13, 41: PRINT " "
 LOCATE 14, 39: PRINT " "
 PLAY "n48l64p4"
 ELSE OUT ad0, (INP(ad0) OR 1)
 FOR i = 10 TO 15: LOCATE i, 43: PRINT CHR$(222): NEXT i
 LOCATE 13, 41: PRINT "/"
 LOCATE 14, 39: PRINT "/"
END IF
a$ = INKEY$: IF a$ = "" THEN GOTO loop00
IF ASC(a$) <> 27 THEN GOTO loop00
END
```

leads are for the LED, measure the resistance across the leads with an ohmmeter. If the ohmmeter shows conduction in one direction, those pins are the LED; if neither direction conducts, they are the detector. Checking the LED with an ohmmeter will also show its polarity.

If you want, you can mount the circuit board to the bottom of the base plate. A set of long screws or standoffs can be used as legs, if desired.

**Making a Swipe Card.** The coded card consists of narrow (to represent a "0") and wide (for a "1") bars separated by blank white spaces. The wide bar must be at least twice as wide as the narrow bar, and the blank must be as wide, if not wider, than the aperture. The bars should be positioned on the card so their bottoms are within $^1/_8$ inch of the card's bottom. Finally, the bars should be at least ½-inch high.

The bars are read right-to-left when looking at the card with the bars at the bottom. The first bar is always narrow—it is a reference bar and is not part of the binary code. The next fifteen bars are a binary representation of a number between 0 and 32767. The first bar after the reference bar is bit 0, with each bit proceeding in order from there up to bit 14.

Making a swipe card is easy with the program in Listing 1. When you enter a number between 0 and 32767, the resulting barcode is displayed on the screen. To print that pattern on a card, press "H". Once printed, cut away the excess paper so that the card will be the correct size. The program marks where the edges of the card should be as a guide.

Some printer inks are not IR absorbing (such as the ink used in Hewlett Packard ink jet printers). The best results are obtained with a laser printer or by photocopying a card that has been printed. If you don't have access to a laser printer or a photocopier, you can fill in the bars with a felt-tipped pen that has IR-absorbing ink. You can use the InfoCard's testing and calibration program in the next section to find out if the particular felt-tipped pen you plan to use will do the job.

**Testing and Calibration.** Apply power to the InfoCard, connect it to a PC's printer port, and load the QBASIC program in Listing 2. Using a DC voltmeter, adjust R7 until the voltage on pin 8 of IC2 is about 4 volts.

Place a card in the card guide so that a wide bar is directly in front of the aperture. Check to see if LED1 is lit. If it is not, turn R7 to increase the voltage level on pin 8 of IC2 until LED1 comes on. Start turning R7 the other way slowly until LED 1 goes out, then add an additional ¼ turn. If the swipe card is moved so that SEN1 sees the white of the card, LED1 sould turn back on.

If that procedure does not work as it should, check the accuracy of the circuit wiring, make sure that all components are properly orientat-

**LISTING 3**

```
REM ** ICARD.BAS
REM ** Version 970720
REM
CLS : DEF SEG = 64: ON ERROR GOTO errorloop
DEFINT A-B, X: DIM a(25), b(25)
ad0 = 888: ad1 = 889
access1 = 226: 'If this code found, Relay will activate.
timerelayon = 10: 'Time Relay Stays On.
timeforerror = 5: 'Time to wait when an error occurs before resetting.
'
'**PROGRAM BEGINS
'
loop01:
CLS : LOCATE 10, 36: PRINT "Ready..."; : x = 0: xo = 0: OUT ad0, 3
WHILE (INP(ad1) AND 128) = 0: WEND: 'Wait for Card
'** Card In. Turn Off LED and Wait for Bars.
OUT ad0, 2
WHILE (INP(ad1) AND 128) = 128: WEND
'** First Bar Found.
redo1:
WHILE (INP(ad1) AND 128) = 0: x = x + 1: WEND
IF (x - xo) < 10 THEN x0 = x: x = 0: GOTO redo1: 'Software DeBounce
a(0) = x: b(0) = 0
'** Width of first (reference) line measured as a(0)
FOR i = 1 TO 15
redo01:
x = 0
'Wait for next line.
WHILE (INP(ad1) AND 128) = 128: WEND
'Determine Width of Line.
WHILE (INP(ad1) AND 128) = 0: x = x + 1: WEND
IF x < .1 * a(0) THEN GOTO redo01: ' Software Debounce
a(i) = x
NEXT i
'** Card Read Done. Ref is a(0). Bits are a(1)-a(15).
loop02:
CLS : code = 0
FOR i = 1 TO 15: b(i) = 0
SELECT CASE b(i - 1)
 CASE IS = 0
 IF a(i) > a(i - 1) * 1.5 THEN b(i) = 1: code = code + 2 ^ (i - 1)
 CASE IS = 1
 IF a(i) > a(i - 1) * .75 THEN b(i) = 1: code = code + 2 ^ (i - 1)
END SELECT
NEXT i
LOCATE 10, 30: PRINT "CODE: "; code
LOCATE 11, 27: PRINT "(";
 FOR i = 1 TO 15: PRINT RIGHT$(STR$(b(i)), 1); : NEXT i: PRINT ")"
LOCATE 18, 20: PRINT "<Esc> Ends, Any Other Key Continues...";
blink01:
IF code = access1 THEN blink1 = 0: blink2 = 1 ELSE blink1 = 2: blink2 = 3
 OUT ad0, blink1
start1! = TIMER
 WHILE (TIMER - start1!) < timerelayon
 OUT ad0, blink1
 start! = TIMER
 WHILE (TIMER - start!) < .15: WEND
 OUT ad0, blink2
 start! = TIMER
 WHILE (TIMER - start!) < .15: WEND
 a$ = INKEY$
 IF a$ <> "" THEN
 IF ASC(a$) = 27 THEN OUT ad0, 2: END ELSE GOTO loop01
 END IF
 WEND
GOTO loop01
errorloop:
LOCATE 10, 15
BEEP: PRINT "Error Reading Card. <Esc> to End, or Wait For Reset.";
start! = TIMER
WHILE (TIMER - start!) < timeforerror
 a$ = INKEY$: IF a$ <> "" THEN a = ASC(a$) ELSE a = 0
 IF a = 27 THEN OUT ad0, 2: END
WEND
RESUME loop01
```

ed, and look for other basic errors that occur when building an electronic circuit. Double-check the wiring to SEN1. If you are not using a swipe card created on a laser printer or photocopier, the ink you are using might not be good for use with the InfoCard.

**Using InfoCard.** The main program for using and demonstrating the InfoCard is shown in Listing 3. Notice the variables *ad0, ad1, access1, timerelayon,* and *timeforerror* in the first few lines of the program. Variable *ad0* is the address of the parallel port you will be using. A decimal address of 888 is the default location for LPT1. Variable *ad1* points to the location just after *ad0*. As an alternative, you can set *ad1* to equal *ad0* + 1. That way, if you change the port that you're using, *ad1* will automatically track which port you are using. Variable *access1* is the card code that will activate LED1. Variables *timerelayon* and *timeforerror* set the time duration, respectively, of how long LED1 will remain on and how long the program will wait before resetting itself if an error occurs. You can change each of those variables to suit your needs.

With the program running and the InfoCard hardware connected and powered up, the screen will simply say "Ready". Run a card through the reader. The card's value will be displayed. If the value matches the value in *access1*, LED1 will light. Pressing the Escape key will end the program, while pressing any other key or waiting for the time specified by *timerelayon* will reset the program to the "Ready" mode. If the card doesn't read properly, the screen will display "Error in Reading Card". You can either press the escape key to end the program or wait for the program to reset itself to the "Ready" mode. In that case, the delay time before reset is controlled by the *timeforerror* variable.

**Relays and Other Options.** Replacing LED1 with an optoisolator will let you interface the InfoCard with other hardware that can be controlled by an on-off-style switch. Devices such as the MOC3010

*(Continued on page 49)*

# BUILD A DIGITAL-STORAGE OSCILLOSCOPE FOR YOUR HIGH-PERFORMANCE LOGIC ANALYZER

*Combine this add-on device, March's Logic Analyzer, and almost any PC, and get a full-featured digital-storage oscilloscope.*


ROBERT G. BROWN

Everyone who works with electronics would like to have a decent oscilloscope as a part of their bench equipment. Unfortunately, top-end oscilloscopes command top-end prices, putting them out of reach of some hobbyists. No doubt you've studied the article "Build a High-Performance Logic Analyzer" that was featured in the March 1998 issue of **Electronics Now**. That device sported an expansion port to which you could attach additional add-on modules.

As promised, this month we are presenting such an add-on module. With this module, you can turn the High-Performance Logic Analyzer into a 40-million-samples-per-second dual-trace digital-storage oscilloscope. Like the Logic Analyzer, the digital-storage oscilloscope, or DSO, connects to any PC and only requires DOS to run the host software with a CGA or greater display. Those computer requirements mean that you can easily recycle that old PC that can't run any modern software, but is still too good to just get rid of.

The unit itself can sample two analog channels and four digital inputs simultaneously. The sampling rate can be chosen from any of 10 built-in rates ranging from 40 MHz down to 312.5 kHz. If those rates don't fit your needs, you can use either of the logic analyzer's two external clock inputs. The oscilloscope features include the ability to use standard 10X scope probes, three trigger modes including a sweep-triggered mode with settable level and slope, plus triggering of the storage cycle with the digital-logic inputs.

Like the logic analyzer that it works with, the DSO can store up to 2048 samples. Additional advantages of a computer-based DSO include the ability to capture and view a transient signal, both before and after the trigger event, and the ability to save the captured data to disk for printing and later study.

**Designing a DSO.** The functions of a logic analyzer and digital-storage oscilloscope are in many ways very similar. In a DSO, digitized analog signals are stored for later display, much like a logic analyzer, which stores digital signals for later display.

To take advantage of that fact, the companion logic analyzer was designed to hold all of the functions that are common to both devices. That way, the DSO module is simply an analog front-end for the logic analyzer. The main advantage to that approach is that it helps keep the cost of the project down. The result is having two very powerful test instruments, a logic analyzer and a digital-storage oscilloscope, for about the same cost as a digital-storage oscilloscope alone.

**Circuit Description.** The schematic diagram for the DSO is shown in Fig. 1. The two analog channels are identical, so only one channel will be described; the other channel works the same way. The input signal is buffered by IC1-a, a high-speed FET-input op-amp. There is no gain in that first stage as its only function is to prevent loading the source of the input signal—which is why the op-amp has a FET-based input. The actual input impedance is set by R1 and the scope-probe resistance (usually 9 megohms for a 10X probe).

The buffered signal is then fed into high-speed op-amp IC2-a, which is configured as an inverting amplifier. The amplifier's gain can be varied with R7. An offset voltage is also added so that the amplifier signal will be within the proper voltage range needed for digital conversion. The offset voltage source comes from IC4, the analog-to-digital converter. The reference voltage is buffered by IC3-b, and then inverted by IC3-a. The amount of offset can be varied with R13 in order to adjust the DSO's ground reference voltage.

The final output signal is then fed through R16 into IC4. A Zener diode, D1, protects the input of IC4 from excessive input voltages. That chip, a dual high-speed six-bit analog-to-digital converter, is the heart of the DSO. The rate at which the DSO takes samples is controlled by the logic analyzer through a clock signal on pin 24 of J2. Both scope channels are digitized at the same time with each clock pulse. The sample rates of the DSO are therefore the same as the rates available from the logic analyzer. The six-bit digitized signals convert the analog signal into one of 64 levels. The digital data is buffered by IC5 and IC6. The signals are passed to the logic analyzer through J1. A series of 33-ohm resistors (R20 through R33) provide termination for the data signals.

Since the DSO produces six bits per channel for a total of 12 bits and the logic analyzer has a total capacity of 16 channels, four bits are unused. Those four bits are made available as additional digital channels on the DSO as TP4–TP7. The digital channels connected to TP4 and TP5 can be used as an external trigger on a given logic condition instead of the standard triggered sweep.

There are three test points on the board that are used for probe calibration. They can also be very handy for testing the DSO and troubleshooting the unit. A steady logic low and high are available at TP2 and TP3, respectively. A 312.5-kHz squarewave signal from the logic analyzer (via pin 26 of J2) is available on TP1 as a calibration signal.

Because IC4 is a mixed-signal device—a combination of analog and digital circuits—multiple power

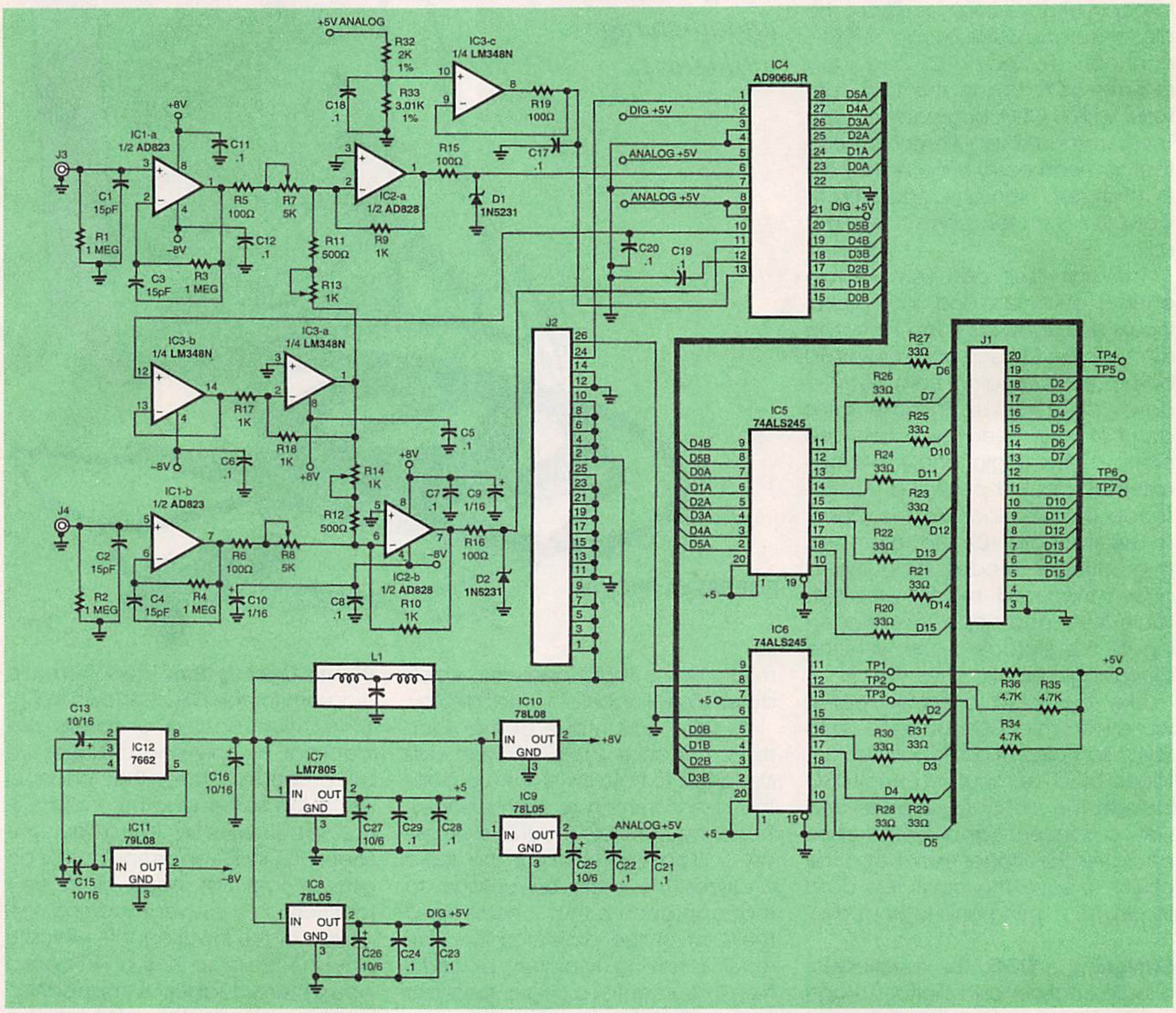



*Fig. 1. The Digital-Storage Oscilloscope is an add-on module for the High-Performance Logic Analyzer. It is built around a two-channel, 6-bit analog-to-digital converter. Four additional digital-logic channels are included as a bonus.*

and ground pins are used to improve performance. Separate supply-voltage regulators are used to minimize any noise that might be present.

To further improve the noise immunity and response of the DSO, external reference voltages are used for IC4 instead of the chip's internal references. The high-end reference has been raised to 5 volts available from IC9, while the low-end reference has been set to 3 volts by R32, R33, and IC3-c.

Power for the DSO module is supplied from the logic analyzer through J2 and L1, a 3-pin EMI filter that removes digital noise from the power line. The filtered 12-volt power feeds the various positive-voltage regulators in addition to IC12, a 7662 voltage inverter. That inverter creates a negative voltage, which is regulated to –8 volts by IC11.

**Building the Digital-Storage-Oscilloscope Module.** Construction of the DSO is very similar to, if not exactly like, the companion logic analyzer. Reviewing the construction section of that article is a good idea before beginning. You should also get a copy of the DSO software either from the Alta Engineering Web site (http://www.gutbang.com/alta) or from the Gernsback FTP site (ftp://ftp.gernsback.com/pub/EN/altadso.zip). As an alternative, you can get the software from the source given in the Parts List. Like the logic analyzer, the DSO software doubles as a demo, letting you see what the DSO can do before actually building the module. Any last-minute suggestions or details that do not make it into print will be included with the software. You will need to unzip the file using PKUNZIP or another unzip program. The DSO module connects to the High-Performance Logic Analyzer, so you will need to have built and tested that unit as well.

Like the logic analyzer, the DSO module should only be built on a double-sided PC board with plated-through holes. The layout of the components and traces are very critical to proper operation, so no other construction method is likely to work. You can make your own PC board from the foil patterns included here, or one can be purchased from the source given in the Parts List.

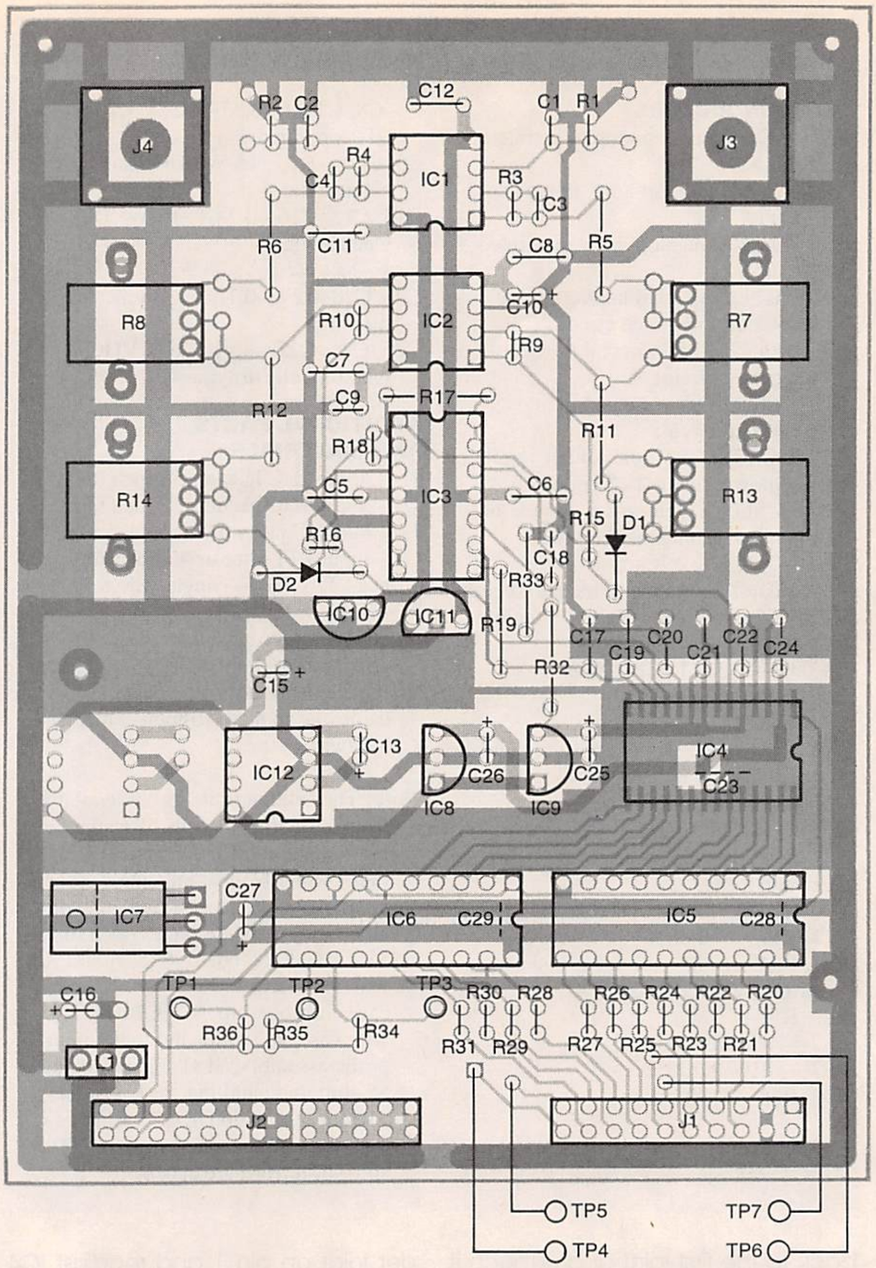



*Fig. 2. Here is the parts-placement diagram for the DSO. Note that IC7 is mounted "upside down" from the normally-expected position—the metal tab will be pointing away from the board. Three surface-mount capacitors are soldered to the bottom side of the board.*

Since IC4 is a fine-pitch surface-mount device, a low-wattage fine-tipped soldering iron should be used. The solder should be the smallest diameter that can be found—$^1/_{32}$-inch or less will work well. With a purchased board or one made from the foil patterns, we can begin construction by following the parts-placement diagram shown in Fig. 2.

Start by soldering C23, C28, and C29 to the bottom side of the board. A good technique is to first coat one of the pads with some solder. Place the capacitor on the board and hold it in place with a small screwdriver. Touch the same pad lightly with the soldering iron to re-flow the solder and tack the capacitor in place. Use a magnifying glass to carefully check the position of the capacitor to be sure that it is properly seated on the pads. Fix any alignment errors before continuing. When the part is properly aligned, solder the other end in place, being sure to create a well-coated solder joint. Once that joint is allowed to cool down, go

## PARTS LIST FOR THE DIGITAL STORAGE OSCILLOSCOPE MODULE

**SEMICONDUCTORS**

IC1—AD823 dual op-amp, integrated circuit
IC2—AD828 dual op-amp, integrated circuit
IC3—LM348 quad op-amp, integrated circuit
IC4—AD9066JR dual analog-digital converter, integrated circuit
IC5, IC6—74ALS245 octal transceiver, integrated circuit
IC7—7805 5-volt voltage regulator, integrated circuit
IC8, IC9—78L05 5-volt voltage regulator, low-power, integrated circuit
IC10—78L08 8-volt voltage regulator, low-power, integrated circuit
IC11—79L08 8-volt negative-voltage regulator, low-power, integrated circuit
IC12—7662 voltage inverter, integrated circuit
D1, D2—1N5231 Zener diode

**RESISTORS**

(All resistors are ¼-watt, 5% units unless otherwise noted.)
R1–R4—1-megohm
R5, R6, R15, R16, R19—100-ohm
R7, R8—5000-ohm, potentiometer, printed-circuit mount
R9, R10, R17, R18—1000-ohm
R11, R12—500-ohm
R13, R14—1000-ohm potentiometer, printed-circuit mount
R20–R31—33-ohm
R32—2000-ohm, 1%
R33—3010-ohm, 1%
R34–R36—4700-ohm

**CAPACITORS**

C1–C4—15-pF, ceramic disc
C5–C8, C11, C12, C17–C22, C24—0.1-µF, ceramic disc
C9, C10—1-µF, 16-WVDC, tantalum electrolytic
C13, C15, C16—10-µF, 16-WVDC, electrolytic
C14—Not used
C23, C28, C29—0.1-µF, ceramic, surface-mount
C25, C26, C27—10-µF, 6-WVDC, tantalum electrolytic

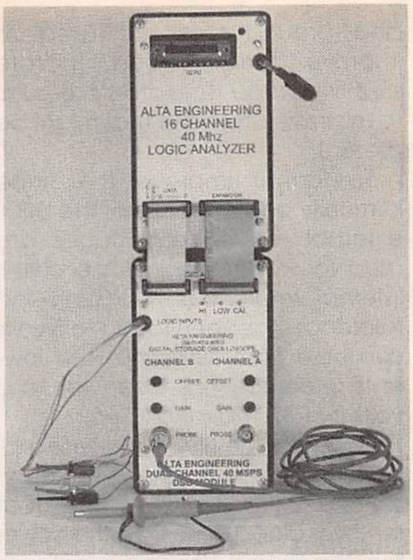
**ADDITIONAL PARTS AND MATERIALS**

J1—20 pin IDC header .51-inch tail
J2—26 pin IDC header .51-inch tail
J3, J4—BNC jacks, PC mount
L1—Input RFI filter or 400 mA ferrite bead TP1–TP3—Single-wire test points
TP4–TP7—Mini clips
20-conductor female connectors, 20-conductor ribbon cable, 26-conductor female connectors, 26-conductor ribbon cable, 4-conductor ribbon cable, case, hardware, etc.

**Note:** The following items are available from: Alta Engineering, 58 Cedar Lane, New Hartford, CT 06057-2905; Tel: (860) 489-8003; E-mail: alta@gutbang.com; Web: http://www.gutbang.com/alta: DOS software on 3½-inch disk, $10; Blank PC board, $45; Board Kit with software, $139; Board Kit with case and software, $169; Board Kit with case, software, and logic input probe assembly, $181. Please include $5 shipping/handling for US orders, $10 for international. CT residents must add appropriate sales tax. VISA and Mastercard are accepted.

back to the first joint and retouch it if needed. After each capacitor is soldered in place, use an ohmmeter to check for any shorts across the capacitors that might have been caused by solder bridges.

Installing the surface-mount capacitors was good practice for soldering IC4, which we'll tackle next. Place that device in the correct location on the component side of the board and carefully align the leads so that they are centered on the pads. When you are sure of the alignment, carefully tack down pin 1 with a light touch of solder. That will hold the chip in place. Again, check the lead-to-pad alignment with a magnifying glass. If the alignment is not correct, re-melt the solder joint on pin 1 and readjust IC4 when it is free. Do not try to move the chip until the leads are free, or they will bend—a condition that is almost impossible to fix. Once the leads are lined up, solder pin 15. That will secure IC4 to the board. Carefully solder the remaining pins in place using a light touch and only enough solder to cover the joint. Do not solder pins next to each other. Instead, skip around the chip. That will prevent excessive heat from building up at any particular location. You should also not be in a rush to complete the task. When all of IC4's leads have been soldered, examine your workmanship with a magnifying glass. Look at the joints from several different angles to be




*When the digital-storage-oscilloscope module is hooked up to the logic analyzer, your setup will look like this. The combined instruments make an almost unbeatable pair for testing and troubleshooting both digital and analog circuits.*

sure that they are solid all the way around. Sometimes a bad joint can look good from the top, but it clearly is not properly bonded to the pad when seen from the side.

After taking a short break to relax, continue by mounting the rest of the capacitors and resistors. Keep in mind that IC4 is sensitive to static electricity—take the proper electrostatic-discharge precautions when handling the board. Note that most of the resistors are mounted vertically.

Next, mount L1 and the connectors in place. If you are going to be using a ferrite bead instead of the RFI filter for L1 (see Parts List), thread the bead onto a length of wire and solder it into the two outer holes—the center hole remains unused.

The voltage regulators should be mounted before the rest of the semiconductors. That way, you can do some simple checks of the power supply before installing the rest of the integrated circuits. If you want, you could use a socket for IC12. Once IC7–IC12 are mounted, check for any shorts between the 12-volt input on J2 and ground. If there are no shorts, or any shorts you found have been fixed, temporarily connect a 12-volt supply across pin 1 (12 volts) and pin 25 (ground) of J2. The voltage at pin 8 of IC12 should be 12 volts. Use the schematic diagram in Fig. 1 to test the volt-

## SOFTWARE CONTROLS FOR THE DIGITAL-STORAGE OSCILLOSCOPE

**F1—Scope mode.** This selects the mode of operation from CONTINUOUS, SINGLE or NORMAL. In CONTINUOUS mode, the scope ignores any trigger conditions and continuously acquires and displays data. That mode is useful to view DC signals and to adjust the gain pot and offset pot or to determine the trigger levels. In NORMAL mode, the scope acquires and then displays only when the trigger condition is met. That mode is like the standard sweep-trigger mode in an analog oscilloscope except that you can view data from before as well as after the trigger. The SINGLE mode is the same as the NORMAL mode except that only one sample of data is acquired and displayed.

**F2—Trigger level X/16 of full scale.** This sets the trigger level for channel A in relation to the full scale of channel A. For example, if it is set for 8/16 then the trigger level is at mid-scale.

**F3—Trigger slope ±.** This sets the trigger slope to either rising ("+") or falling ("-"). If the trigger is set for 8/16 and the slope is set to rising, then the trigger will occur when the input signal rises from below mid-scale to above mid-scale.

**F4—Trigger mode SCOPE/DIGITAL.** This selects the type of trigger from either SCOPE for normal scope triggering using the level and slope of the channel A signal or digital logic triggering using the logic inputs 0 (TP4) and 1 (TP5). The logic trigger operates in the same manner as the logic analyzer trigger. See the discussion of logic triggering in that article for a complete explanation.

**F5—Clock rate.** This selects the clock rate at which the DSO acquires data. You can select any clock rate from 312.5 kHz to 40 MHz. At a rate of 40 MHz, a sample is taken every 25 nanoseconds. Using a lower rate lets you acquire and view data over longer periods.

**F6—Acquire.** This starts the data acquisition and display. Each scope channel has a separate grid and the four logic channels are at the bottom of the screen. Each channel is labeled on the left-hand side of the screen. The trigger location is shown by a short vertical line at the top of the grids if the trigger position is within the display. The time displayed at the top left of the grid is the number of microseconds at the start of the grid in relation to the trigger position. For example, a time of –3.2 microseconds shows that the displayed data starts at a point 3.2 microseconds before the trigger. If the time is positive, it means that the data shown is from after the trigger. You can view more of the data using the PageDown and PageUp keys to move back and forth one screen of data at a time. The END and HOME keys will jump to the start or end of the data sample. Press the escape key at any time to return to the menu.

**F7—Display.** This option displays the data currently stored in the program. When the program is first started before any samples have been taken, it will show some sample data that is a sawtooth waveform. You can also use this option to view data that has been recalled from a data file that has been stored on disk (see F8). The PageDown, PageUp, HOME and END keys work the same way as with F6 (Acquire).

**F8—File.** This option lets you save data and setup information to a file on disk for later viewing. You can also load saved data from a file with this option. The archive ALTADSO.ZIP has several data files that you can view. The CALLO, CALHI, CALCAL files are examples of correct probe compensation. The file VIDEO.DAT shows data captured from a composite video signal.

**F9—Configure.** This is the same as the configure option for the logic analyzer. If you have already configured the logic analyzer, you do not need to use this option.

**F10—Exit.** This quits the DSO program.

age at each pin location for all of the ICs. The voltages should be +5 volts, +8 volts, or –8 volts, as shown in the schematic diagram. Any problems should be tracked down and fixed before continuing.

When mounting the ICs, you may use sockets for all of the components except IC1 and IC2—those parts should be soldered directly to the board. Since the ICs are orientated in different directions on the board, double-check their orientation before soldering. It is a good idea to repeat the power-supply test with the ICs in place to catch any other assembly errors.

The three test points will need to be covered with insulating tubing to a height of a little more than a half inch if the case you will be using has a metal panel. You can use ribbon wire that has been split down and partially séparated or individual lengths of stranded wire for the digital probes connected to TP4–TP7. A good length for the wires is 12 inches, but they should not be longer than 18 inches. A set of jumper cables should also be made from 20-conductor and 28-conductor ribbon cable. Those cables will connect the DSO to the logic analyzer. The lengths of the cables should be as short as possible to reach between the connectors between the two units. A length of about 2½ inches should be about right.

Drill appropriate holes in the front panel of the enclosure that you will be using for the DSO. Mount the completed PC board to the back of the front panel with screws and threaded standoffs. The DSO is now ready for testing.

**Testing the DSO Module.** The logic-analyzer module should be connected to a computer and turned off. Connect the DSO to the logic analyzer with the ribbon cables and turn the logic analyzer on. You should check for +12 volts at pin 8 of IC12 on the DSO board. If that voltage is not there, you should shut off the power immediately and track down the cause of the problem.

You should have the program ALTADSO.EXE in the same directory on your PC as the logic-analyzer program ALTALOG.EXE. Both programs use the same configuration file, so once you have the logic analyzer configured, it will not be necessary to configure the DSO. Both programs are very similar, so once you are familiar with the logic-analyzer program, you will also understand the basics of the DSO program.

Start up the ALTADSO program from the DOS prompt. Press the F1 key and set the option to "SINGLE". Connect the logic probe from TP7 to TP1, then acquire a sample. The display should look like an oscilloscope screen with the four digital channels showing at the bottom of the display. The very bottom trace is from TP7; it should be showing a squarewave signal that alternates between the low and high levels. Press the escape key to return to the main menu. Repeat that test with the other probes and verify that they all produce squarewave signals.

Connect a scope probe to the BNC connector of channel A. A standard 10X probe rated at 60 MHz can be purchased from a number of mail-order sources for under $20. If

the probe has a 1X–10X–REF switch, set the switch to "REF," otherwise, short the probe tip to the ground clip. Set F1 to CONTINUOUS mode and press F6 to begin acquiring samples. You should see a level trace in the top part of the grid that has an "A" on the left side. Turning R14 should move the trace up or down on the grid. There might be a short delay between adjusting the pot and seeing the results on the display, which is normal. Switch the probe to "10X" and connect it to TP1. You should see a squarewave signal on the A channel. Turning R8 will change the amplitude of the squarewave. If everything is working as described, test the B channel in the same way. If not, use a voltmeter to trace the signal path through the op-amp circuit looking for errors. When everything is working properly, mount the board in the case.

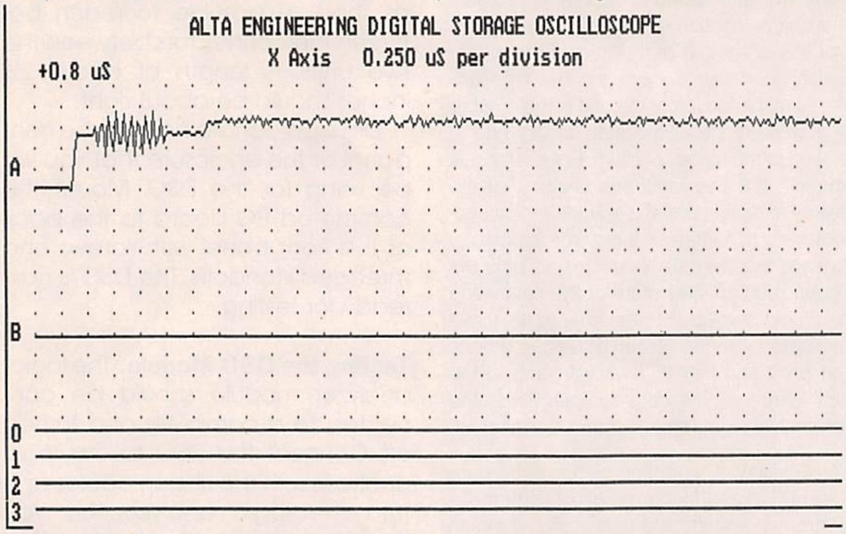
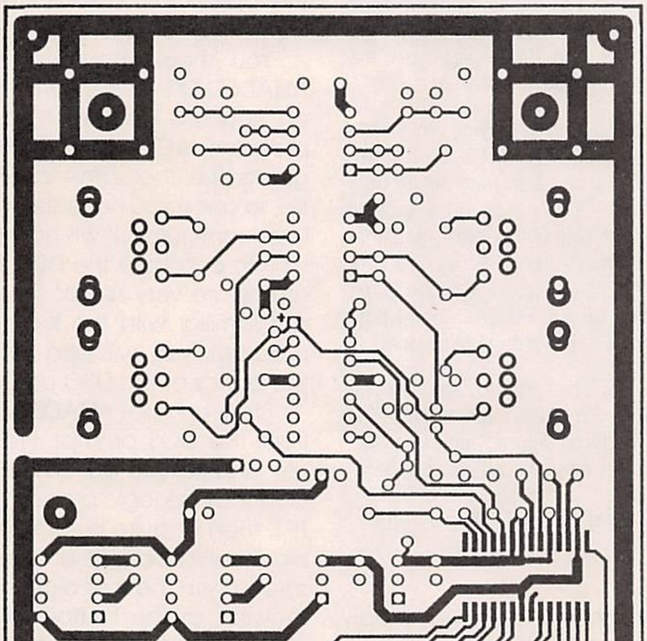



*Fig. 3. The DSO software turns an IBM PC into a sophisticated piece of test equipment. As seen in this screenshot, there are two analog channels plus four digital channels. What's more, the software will work with a graphic display as low-resolution as CGA!*

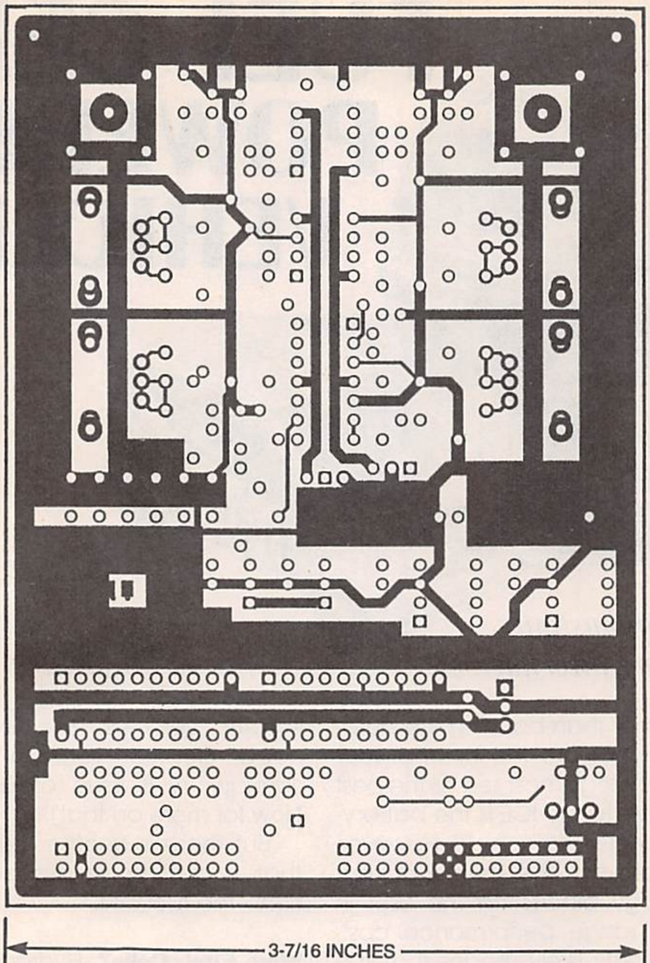
**Probe Compensation.** All 10X scope probes have an adjustment that is used to match the probe to the scope input. Once a probe is adjusted to match a particular channel, that probe should always be used with that particular channel.

The adjustment procedure for the DSO module is slightly different from most scopes. Begin by setting the probe switch to "10X" and connect it to TP2. Select the CONTINUOUS mode with F1 and then start to acquire samples with F6. You should get a flat trace on the display grid. Use R14 to move the trace to the first grid line from the bottom of the grid display for that channel (remember, channel A covers the top part of the scope grid). Once the trace is on the correct grid line, connect the probe to TP3. Now use R8 to bring the trace to the second grid line from the top of the display. Once that trace is at the correct grid line, you should move the probe to TP1. The display will show a squarewave. Without touching any of the potentiometers on the DSO, adjust the probe's compensation until the top and bottom of the squarewave is at the same grid lines that were used for setting R14 and R8. Repeat the procedure for the other channel. A different probe should be used with each channel; mark each one as to which channel it was calibrated for. If you are not sure about the level settings for probe compensation, detailed information is built into the program and can be viewed by pressing F7 or F8.

**Using the Digital-Storage Oscilloscope.** At this point you are ready to use the Digital-Storage Oscilloscope. However, before you dive in and begin experimenting with the DSO, there are two important warn-




*Here's the foil pattern for the component side of the DSO board.*




*Here's the foil pattern for the solder side of the board. If you make your own board, the holes should be plated through.*

ings that you should keep in mind. First of all, the maximum input voltage with the probes in 10X mode is ±60 volts; with the probes in 1X mode it is only ±8 volts. The second point is more important—before hooking up the DSO to a new circuit, check to be sure that there is no AC potential between the grounds of the circuit and the DSO.

A typical display of the DSO software is shown in Fig. 3. You have already become somewhat familiar with a few of the DSO's operational modes from testing and calibrating. See the sidebar for a more detailed explanation of each menu option.

To experiment with the various options, hook up the channel A probe to the TP1. Set the scope mode to NORMAL, the trigger mode to SCOPE, the trigger level to 8/16, and the slope to "+". Press F6 to acquire a sample. You should see a squarewave with the rising edge of the signal under the little trigger-position mark. Press the escape key and then set the trigger slope to "–". Press F6 to acquire another sample, and the trigger-position mark will be over the falling edge of the squarewave. When the trigger is set correctly, a repetitive signal should be steady in the display. You can experiment with the gain and offset adjustments and the other trigger settings using TP1. Remember, if the trigger condition is not met, the display will not be updated.

A Digital-Storage Oscilloscope is probably one of the handiest instruments to have on a test bench. The author welcomes questions, comments, and suggestions. He can be contacted through e-mail at alta @gutbang.com, by telephone at (860) 489-8003, or by visiting the Alta Engineering Web site at http://www.gutbang.com/alta. Ω

## INFOCARD CARD SCANNER

*(continued from page 42)*

(which has a Triac-controlled output) can be used to control AC-based devices. With a simple transistor switch, a small relay could also be activated. If you do not want to remove LED1, the demonstration program also activates pin 3 of the printer port along with LED1. Multiple output circuits can be hooked up to pins 4 through 9 with modification to the program. If you use that pin, be careful of any circuit that you connect to the computer's hardware—you might end up damaging your printer port.

**TABLE 1**

| J1 Pin No. | BASIC Function |
|---|---|
| 10 | INP (*address*) AND 64 |
| 11 I | NP (*address*) AND 128 |
| 12 | INP (*address*) AND 32 |
| 13 | INP (*address*) AND 16 |

Multiple InfoCards can be hooked up to the same computer if, for example, you want to read cards from different locations. The basic circuit built around IC2-b is all that is needed. If you do not use LED1, a single LM339 can be used for up to four InfoCard stations. Of course, the program will have to be modified to accept input from the different stations. Table 1 shows how to change the input statement in the program to read card information from different input pins.

The InfoCard software could also be integrated into another program or batch file to control access to lists or other data in the computer depending on a card's code. You can modify the program to have multiple access codes. You can also add routines to look up the code in a database to provide related information about the card holder. How you use the InfoCard is limited only by your imagination! Ω

# FUEL-CELL POWERED VEHICLES


*Are fuel cells the technology that will allow us to replace the polluting internal-combustion engine with a cleaner, good-performing alternative?*

BILL SIURU

It is hard to beat the internal-combustion engine (ICE) when it comes to performance, range, cost, safety, reliability, and user-friendliness. After all, it has been "under development" for over a century. However, there are several compelling reasons to replace the ICE with a different technology.

For one, there is the matter of petroleum resources. The U.S. now imports nearly half of all petroleum consumed by cars and light trucks. That will increase as the number of vehicles and miles driven continues to increase.

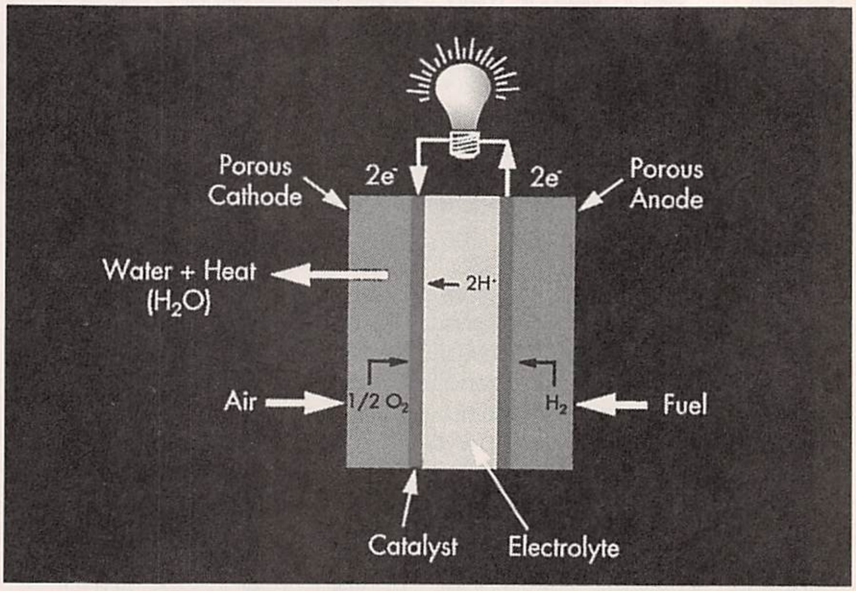
Also, many scientists postulate that global warming results from greenhouse gases, which are produced when fossil fuels are combusted. As such, one of the most significant source of greenhouse gases is the automobile.

Is it possible to reduce those problems by further refining the ICE? Perhaps, but likely not enough to do more than delay the day of reckoning somewhat. Even with the most sophisticated electronic fuel-injection systems and the use of alternative fuels like natural gas, methanol, and ethanol, the ICE cannot meet the zero-emission-vehicle (ZEV) mandates already legislated in California, New York, and Massachusetts and under serious consideration in other states and Canadian provinces.

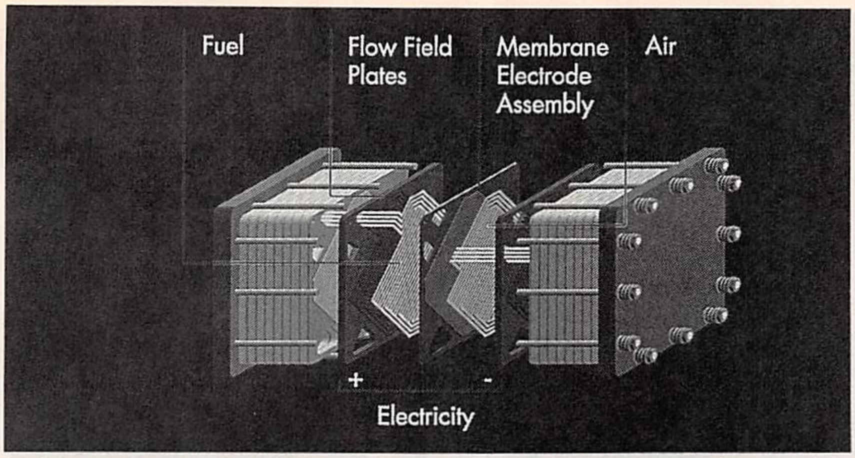
So, other than banning the automobile, what are the alternatives? The technology most see as the best alternative to the ICE is the battery-powered electric vehicle. However, at the present, the limits that that technology places on the user in terms of range, performance, cost, and flexibility likely means that the battery-powered car will never replace the ICE except in narrow niche markets such as for urban transport and as neighborhood electric vehicles (See "Neighborhood Electric Vehicles" in the January 1998 issue of **Electronics Now** for more on that).

But there is another technology that is getting serious consideration—the fuel cell.

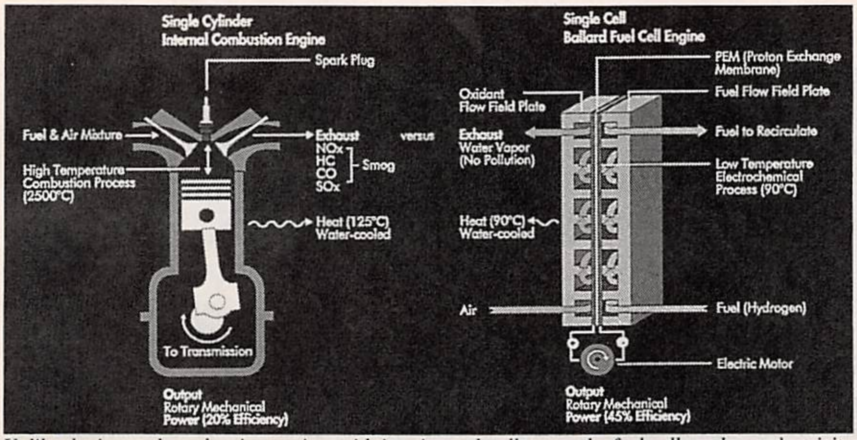
**Why Fuel Cells?** Hydrogen is the ultimate clean fuel. When combined with air to produce energy, only heat, water, and a small amount of oxides of nitrogen (NOx)




*How a fuel cell works. Each membrane assembly consists of electrodes (anode and cathode) with a thin layer of catalyst, bonded to either side of a proton-exchange membrane (PEM). Air flows through the channels in flow-field plates to the cathode. Oxygen in the air attracts the hydrogen protons through the proton-exchange membrane. The air stream also removes the water created as a by-product of the electrochemical process. (Ballard)*




*Stacking together more PEM cells increases the voltage, while increasing the surface area of the cells increases the current. (Ballard)*




*Unlike the internal-combustion engine, with it noise and pollutants, the fuel cell produces electricity quietly and cleanly with water as the by-product. (Ballard)*

are produced as by-products. There are no greenhouse gases. Some say the 21st Century will be the "Hydrogen Century" as hydrogen replaces fossil fuels. Hydrogen is extremely abundant, indeed the most abundant element in nature, and is a renewable resource. It is available worldwide since it can be produced from many sources from natural gas to bio-mass including agriculture crops and landfill waste. Using electrolysis, hydrogen can be produced from water anywhere that electricity from any source—including "clean" ones such as wind, solar, or hydro power—is available.

All that sets the stage for the current intensive interest in fuel cells for automotive applications. Though the fuel cell was conceived in 1839 by Sir William Grove, it did not really see practical use until the space age when hydrogen-oxygen fuel cells supplied power onboard the Gemini, Apollo and Skylab spacecraft. They are currently used on the Space Shuttle.

**How A Fuel Cell Works.** Like a battery, a fuel cell is an electrochemical device that directly produces DC electricity without combustion and without producing polluting emissions. Like batteries, fuel cells have anodes, cathodes, an electrolyte, and positive and negative terminals. Unlike batteries, they do not have to be recharged. Fuel cells produce electric power as long as they are supplied with fuel (namely hydrogen) and oxygen or air.

Companies like Ballard Power Systems, International Fuel Cells, Plug Power, Mechanical Technology, Inc. and others are working on fuel cells for automotive applications. For instance, Ballard, located in Vancouver, British Columbia, has developed several versions of its Proton Exchange Membrane (PEM) fuel cells that have been installed in prototype cars and buses.

The PEM fuel cell consists of two electrodes (anode and cathode) separated by a polymer-membrane electrolyte. Each electrode is coated on one side with a thin layer of platinum catalyst. That catalyst causes the hydrogen fuel to separate into free electrons and protons (positive hydrogen ions) at the anode. The free electrons are conducted as usable electric current, passing through the external circuit. Like with battery-powered EVs, electrical energy from the fuel cell is supplied to an electric motor, or motors, to propel the vehicle. The protons migrate through the membrane electrolyte to the cathode, where they combine with oxygen from the air and electrons from the external circuit to form water and heat. The heat could be used for passenger comfort, windshield defrosting, etc. The output voltage of the fuel cell is increased by stacking individual cells in series; increasing the surface area of the cells increases the current produced.

**Storing or Making Hydrogen On Board?** Two quite different approaches are being considered with respect to the hydrogen fuel. The nearer term approach is to convert conventional fuels like gasoline, methanol, or ethanol into hydrogen on board the vehicle. The advantage of that technique is that the current infrastructure for transporting and distributing fuels would need little or no change and motorists would see little difference when they refuel.

The longer term approach is to store hydrogen on board as a compressed gas, cryogenic liquid, or in a hybrid material. On-board storage results in a simplified system with higher overall efficiency compared to on-board fuel processing. The disadvantage is that on-board storage requires a completely revamped transportation and distribution infrastructure to handle hydrogen. That could take years to put into place.

An example of a system to produce hydrogen on board is the reformer developed by the Argonne National Laboratory for producing hydrogen from methanol. In the Argonne reformer, a noz-

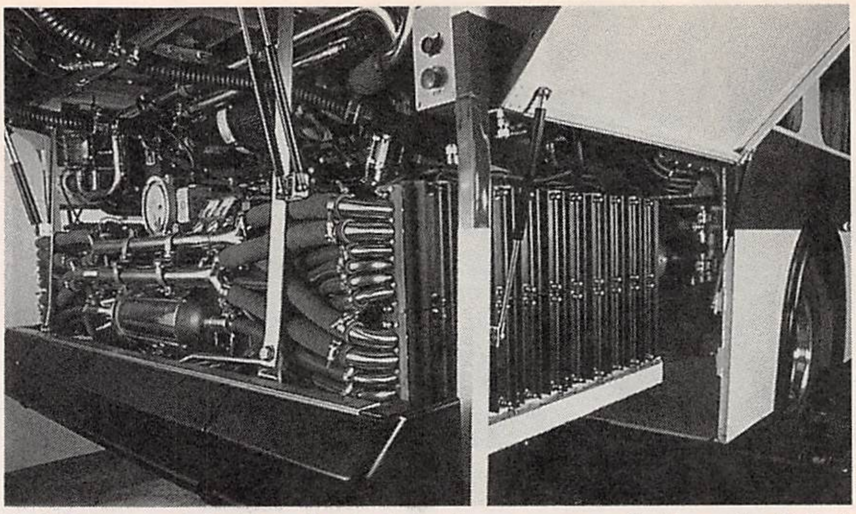
zle sprays liquid methanol into a cylinder and an ignition source starts the chemical process that combines methanol with oxygen from the air to release a hydrogen-rich mixture of gases. That hydrogen-rich gas mixture is injected into the fuel cell. Since the reformer produces both carbon dioxide and carbon monoxide, a small on-board chemical reactor converts the carbon monoxide into carbon dioxide.

Consisting basically of a cylinder packed with a common, inexpensive catalyst, the design is quite simple and would be inexpensive to manufacture. The device is small enough—it takes up less volume than a seven gallon container—to fit under the hood of a compact car. While not as efficient as an on-board hydrogen-storage system, the reformer/fuel cell system could be more efficient than an ICE, yet it produces negligible emissions besides carbon dioxide.

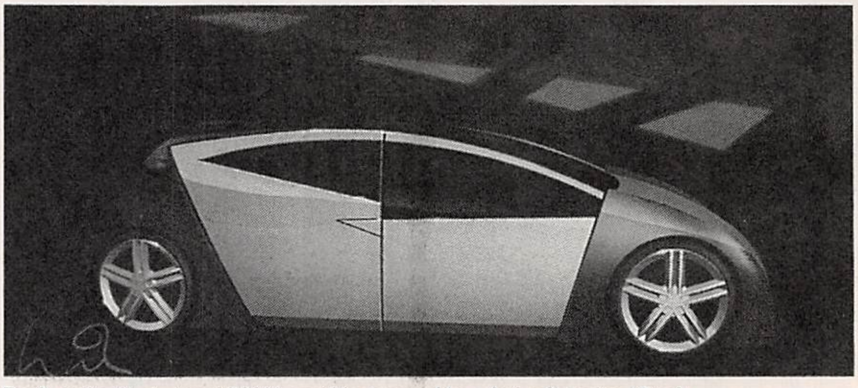
Recently, Plug Power LLC, the Arthur D. Little Research Foundation, and the Los Alamos National Laboratory have successfully developed a gasoline-to-hydrogen reformer. That represents a breakthrough in that it overcomes the problem of fuel-cell poisoning from the high levels of carbon dioxide produced when gasoline is reformed. That is why methanol is being used in other reformer developments.

Unfortunately, largely because of the Hindenburg disaster, extremely explosive hydrogen has a negative image to many people. The hydrogen-filled Zeppelin exploded over Lakehurst, NJ in 1937, killing 36 people. Thus, it could still be a hard sell to convince the public that hydrogen stored as a compressed gas or a cryogenic liquid is safe on the highway. Liquid hydrogen means storage at cryogenic temperatures, which is both complex and expensive. Current compressed gas and liquid hydrogen-storage techniques are heavy and bulky so they greatly limit the range of the vehicle—the same problem that faces battery-powered EVs.

Another solution is to use a metal-hydride storage system. Here, cold hydrogen is absorbed in the hydride material. When heated, the material releases gaseous hydrogen that could be used in a fuel cell. That storage technique is considered safer than either compressed gas or cryogenic storage because the metal hydride releases hydrogen slowly and at relatively low pressure. One drawback is that the storage equipment is still quite heavy and bulky. Therefore, it is most appropriate for use in large vehicles such as buses.



The 275-horsepower Ballard fuel-cell engine fits into the same space as a diesel bus engine. (Ballard)



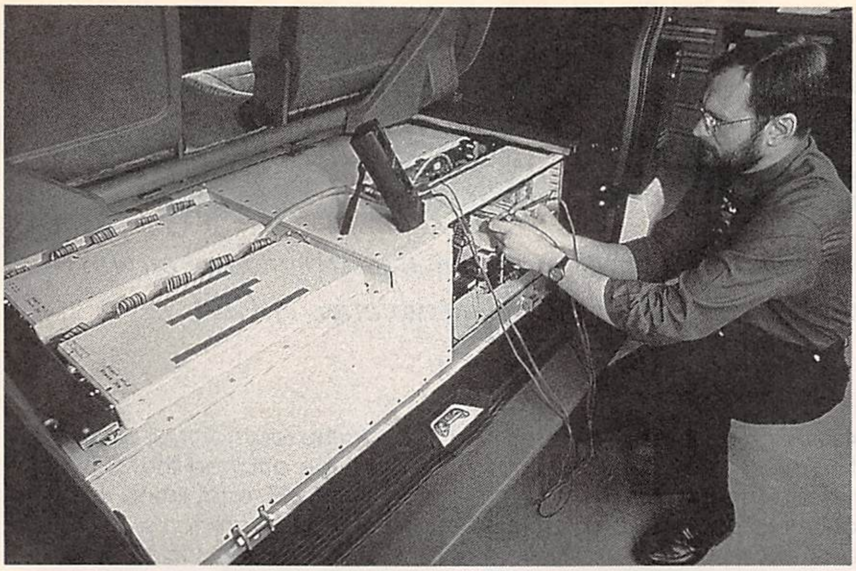
Ford's radically designed P2000 could be powered by a fuel-cell engine. (Ford)

**Buses First.** While it may be a while before fuel-celled passenger cars and light trucks are on the road, fuel-cell buses are already here, at least in demonstration programs under real-world conditions. Buses have the space and can carry the additional weight of fuel cells using today's technology. Also urban mass-transit agencies are interested in reducing emissions either voluntarily or in many cases, to meet government mandates for clean air. According to the California Air Resources Board, a heavy-duty diesel bus generates 11.8 tons of NOx over a 12-year life span. Even so-called clean buses operating on natural gas will emit 5.6 tons of NOx. A fuel cell bus can be designed to emit no NOx.

Ballard Power Systems chose transit buses as the first transportation application for its fuel cells. Ballard's, and the world's, first fuel-cell-powered transit bus went on the road in 1993. It was a 32-foot transit bus with a 125-horsepower Ballard PEM fuel-cell engine fueled directly by hydrogen.

In 1995, Ballard introduced its second bus, a 40-foot ZEV with a 275-horsepower Ballard fuel-cell engine. It has a range of 250 miles before refueling and matches the performance of a diesel transit bus, but without the noxious fumes; and it produces far less noise. The only emission from the tailpipe is warm, moist air.

This year, the Chicago Transit



*The Ballard fuel cells fit under the backseat of the NECAR II minivan and do not reduce the seating or luggage capacity of the vehicle. (Ballard)*

Authority and BC (British Columbia) Transit will each take delivery of three commercial prototype fuel-cell buses. The buses will undergo a two year test program that will provide the necessary performance, cost, and reliability data for commercialization of the final product.

**Fuel-Cell Cars.** Many automakers have fuel-cell R&D programs. Ford, General Motors, and Chrysler are conducting fuel-cell development as part of the Partnership for a New Generation of Vehicles (PNGV)—a partnership between the Federal government and the automakers' U.S. Council for Automotive Research (USCAR) coalition.

Ford is developing a full-performance direct-hydrogen PEM system as part of its P2000 project. "Direct" means that hydrogen fuel is stored onboard the vehicle. The P2000 project is aimed at producing a medium-sized family sedan that weighs only 2000 pounds, or about 1200 pounds less than a Ford Taurus, while being about three times as fuel efficient. Ford is working with International Fuel Cells, and Mechanical Technology, Inc. in this Department of Energy project. Ford recently announced it had demonstrated a 50 kW, automobile-size PEM fuel-cell engine. The system weighs 300 pounds and takes up approximately nine cubic feet, so it could easily fit under a car hood.

Chrysler's Pentastar program is working with Allied Signal on a Design-to-Cost Direct Hydrogen PEM system. Chrysler hopes to have a prototype gasoline-to-hydrogen fuel cell vehicle on the road by 1999. General Motors' Delphi Divisions plus Ballard and DuPont are working on a 30-kW methanol PEM system.

Daimler-Benz recently unveiled the NECAR 3, the third in a series of fuel-cell-powered "New Electric CARs." Over the past couple of years, Daimler-Benz has also developed the NECAR 1, NECAR 2, and NEBUS transit bus. All used Ballard fuel cells. Indeed, Daimler-Benz has acquired a 25% share in Ballard.

Unlike the previous three D-B fuel-cell vehicles, where the hydrogen was stored in heavy and bulky pressurized tanks, the NECAR 3's fuel is stored in rather ordinary fuel tanks. That is because the fuel is methanol. According to Daimler-Benz, methanol was chosen over gasoline and diesel because of its higher efficiency and lower emissions. However, the engineers are considering a multi-fuel system on early-generation fuel-cell-powered vehicles to allow for a phase-in period until methanol is readily available everywhere.

The NECAR 3's methanol reformer uses a water-vapor technique to convert methanol to gaseous hydrogen. Methanol and water vaporize at about 280 degrees C in the reformer to produce hydrogen plus carbon dioxide and carbon monoxide. Following catalytic oxidation of CO, the purified hydrogen is delivered to the fuel cell.

As a demonstration of the practically of its new reformer and fuel-cell technology, the NECAR 3 uses a new Mercedes-Benz A-Class subcompact, a 12-foot long four-door sedan. The compact reformer, which is only about 18-inches tall, is located behind the rear seat along with the methanol tank and control system. The A-Class's innovative double floor sandwich construction allows the fuel cells and auxiliary units to be installed completely under the passenger compartment. The 11-gallon fuel tank holds suffi-

*(Continued on page 68)*

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was designed to measure the degree of theoretical knowledge and technical proficiency of practicing technicians. By acquiring the CET designation, a technician stands out in the electronics industry as being devoted to maintaining the professionalism required by the ever-changing electronics industry. What's more, in the ever-challenging but always demanding job market, a technician who is able to demonstrate his or her ability to perform a job with professional competence and skill has a decided advantage.

It is important to note that while the employment outlook for electronics technicians is strong, to ensure they are hiring experienced and competent workers, an increasing number of employers are now recruiting CETs to fill their servicing positions. What's more, major companies, manufacturers, service centers and educational institutions have come to expect individuals to continue to develop professionally.

It is clear that a strong national certification program is vital to the future of technicians. Proven skill standards and integrity in the development of exams and training programs has earned ISCET the well-deserved reputation as the leader in industry certification. ISCET also recognizes that a technician's need to stay current and proficient does not end with CET certification. That's why ISCET offers certification, training, continuing education, and peer support to those technicians who carry the CET designation. Thanks to ISCET's efforts, the CET program has become widely accepted by technicians, manufacturers, and consumers.

**The Exams.** There are two levels of ISCET certification: Associate and Journeyman. The Associate CET exam is intended for technicians with less than four years of training or education. It consists of 75 questions covering basic electronics, AC/DC circuits, basic math, transistors and semiconductors, electronic components, instruments, test and measurement, and troubleshooting.

*(Continued on page 68)*

BY DON LANCASTER

# The Right Way to Measure AC Power

ACCURATE MEASUREMENT OF REAL-WORLD AC POWER HAS LONG BEEN THE BANE OF BEGINNING EE STUDENTS. THAT'S ESPECIALLY TRUE OF AC POWER IN THE PRESENCE OF PHASE SHIFTS, HARMONICS, AND NONLINEAR LOADS.

Power measurement difficulties also partly explain why "magic lamp" and other misinformed "free energy" pseudoscience scams still persist on the Web. It's also why you probably have not yet done your own careful home-power inventory to try and trim your personal power bill.

Thankfully, there's now bunches of new ways to accurately view and measure AC power. But before we look at these new happenings, let's go over some groundwork.

## AC Power Fundamentals

Work is done any time you have any force actually move something through a distance. Energy is defined as the capacity for doing work. And power is the time rate of doing work. Electrical power is often measured in watts or kilowatts. Electrical energy is sold by the kilowatt hour. (One watt of power over one hour equals one watt hour of energy. A thousand watts for one hour—or one watt for a thousand hours—gives you one kilowatt hour of energy, for which you usually pay your power company a dime.)

Say you have a black box with two access terminals on it. First measure the instantaneous voltage across these terminals, then measure the instantaneous current that is going into one of the terminals. The instantaneous product of the voltage in volts and the current in amps should be your instantaneous power in watts.

If the current and voltage are both positive or are both negative, your instantaneous power is going into the black box. We say the black box acts as a load or a sink that is consuming power. Presumably, the input power is internally developing heat, moving something to where it does not want to go, emitting light, altering chemical states, building up some electric or magnetic field, or otherwise doing some sort of work.

On the other hand, if the terminal voltage is positive and your current is negative or vice versa, we'll say the black box is a generator or a source, which is now producing power. The generated power has to come from some other external energy source by diminishing the strength of any previously built up internal electrical or magnetic fields, through chemical conversion to lower energy states, or by some other means that strictly and absolutely conserves total energy, minus, of course, the irreversible fraction always lost as unrecoverable low-grade heat. Carnot always gets his cut.

**NEED HELP?**

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The tricky thing about AC "loads" is that they sometimes are a source of energy and sometimes are a sink of energy. Thus, power flow in typical real-world AC devices can be a two-way street: In and out.

Let's use Fig. 1 to see some of the problems that power waveforms can cause for us. In Fig. 1A we have an AC source driving a linear resistive load—a hot water heater, maybe. Input voltage (shown) and current (not shown) will both be sinewaves, and they will both be in-phase with each other. Your power waveform should always be positive and should vary at twice the frequency of the input voltage.

In Fig. 1B we drive a nonlinear resistive load—perhaps a hydrogen generator, or something else that might draw disproportionately more current at higher voltages. The current waveform will now involve harmonics. The power waveform is still always positive, and still varies at twice the input frequency. Only this time, the power waveshape peaks are a lot narrower.

In Fig. 1C we show the power waveform typical of a capacitor-input full-wave rectifier. Such a nonlinear switched load is common in many electronic power supplies. Power is only briefly drawn near the middle of each AC half cycle when the diodes conduct. In this case, the current and voltage are still technically in phase, but the current waveform has very strong and objectionable harmonics.

In Fig. 1D you will find the waveform typical of a lamp dimmer set to half brightness. No power at all is drawn for the first quarter cycle till the lamp is turned on by a Triac or a silicon-controlled rectifier. Such a waveform clearly is phase shifted and has strong harmon-

ics. In addition, the sharp leading edge is a possible source of radio interference.

In Fig. 1E we see the input to a pure (ideal) capacitor. The voltage and current waveforms will be phase shifted by precisely 90 degrees, with the current leading. There are times when the capacitor is accepting current and increasing its internal electric-field storage. There are times when the capacitor is producing current and decreasing its internal storage. The average long term power is zero!

Driving any pure inductor would again have the voltage and current waveforms shifted by precisely 90 degrees, only this time the voltage is leading. (This is easy for you to remember using the old but reliable mnemonic ELI the ICE man.) Once again, your current goes both ways, and the long-term power always averages to zero.

In Fig. 1F we view the super important case of a typical motor. Here we have a lagging load that is mostly resistive, combined with the inductance of the motor winding. A power factor can be defined as the cosine of the phase angle. A common power factor of 0.8 implies a phase shift of around 37 degrees. With such a lagging load, the current still goes both ways, except the dominant flow this time is into the motor. Note the two brief and lower power reversals in each line cycle.

I have purposely left the current waveforms out of Fig. 1 to keep things simple. I invite you to sketch all these in as an "exercise for the serious student" as there's lots to be learned here.

Summing up: In just about any reasonable AC device you can think of, the power waveform will be more or less nonlinear. Typically, you'll have a hard-to-measure average long-term value overlain by some cyclic double-frequency waveform. Thus, accurate AC power measurement all comes down to measurement of an arbitrary waveform that

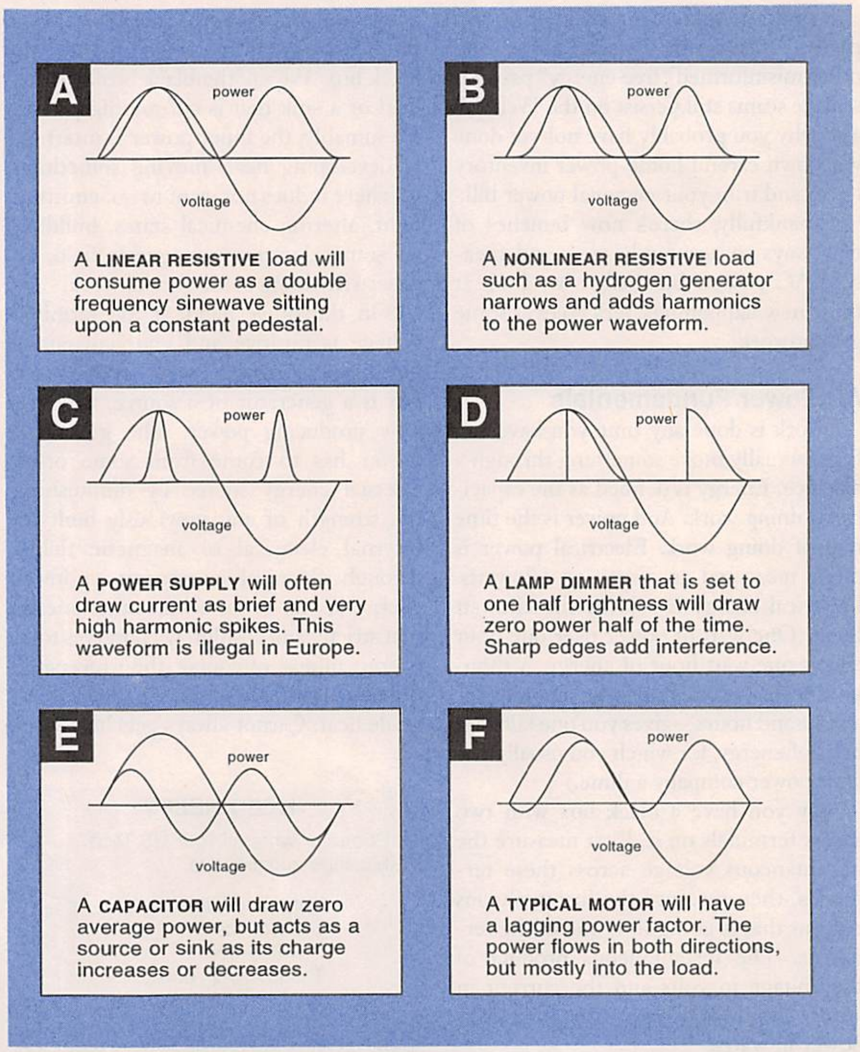


**FIG. 1**—DUE TO THEIR UNUSUAL SHAPES, AC power waveforms have long been very difficult to accurately display and measure.

**TO MEASURE POWER:**

1. Low pass prefilter voltage and current waveforms so they do not change much in an 80 microsecond interval. Do this identically and sharply.
2. Starting with a zero crossing and a minimum of exactly 12,000 line locked times per second, accurately sample and record the voltage.
3. Accurately sample and record the current at precisely the same time the voltage is sampled.
4. Accurately multiply the sampled current times the sampled voltage. Sum these results. Make sure the multiplication accuracy and precision is consistent with the expected crest factors involved.
5. Repeat the measurement, multiplication, and summing exactly 12,000 times. Then divide the summed result by 12,000 to find the ac power consumed or delivered during that one second interval. The result will be both the power in watts and the consumed energy in watt seconds.
6. Multiply the watt seconds by 3600 to get the actual average energy consumption in kilowatt hours.

**TO CALCULATE ELECTRICAL COSTS:**

7. Add up the expected actual use hours per month, taking into account the on-off duty cycle and the exact number of days in the target month. Then multiply this times the kilowatt hours to get the kilowatt hours actually consumed for the chosen month.
8. Multiply the kilowatt hours used per month by the cost per kilowatt hour to find your monthly operating cost. Sum the monthly operating costs to get the yearly operating cost of the electricity used.

**FIG. 2**—ONE USEFUL METHOD to accurately measure AC power.

is formed by the product of two values. Thankfully, these days there is a relatively easy way to make any low-frequency measurement.

## Do It Digitally

Figure 2 shows you a good way to accurately calculate AC power. While you could dream up an analog multiplier circuit, such devices will quickly get into some crest-factor problems. The crest factor is the ratio of your peak power to the average power. Analog solutions tend to get complex if the needed crest factor exceeds three or so. Dimmers (Fig. 1D) and rectifiers (Fig. 1C) often exceed that value.

Instead, the trick is to A/D convert the current and voltage waveforms, sampling them digitally at the same time, and then digitally multiply them together. How many samples do you need? I'd vote for at least 100 per half cycle, or 12,000 per second. That sounds high at first glance, but with the often-seen power waveforms of Fig. 1C, that would only leave you with ten or so non-zero samples per half cycle, and an accuracy at best of five percent.

Note that any power measurement scheme either has to measure one full cycle or else has to measure a "large number" of cycles. Otherwise errors are certain to happen when portions of cycles are unfairly or randomly represented. It does pay to lock your measurement scheme to the voltage or current zero-crossings such that whole cycles are always measured.

Strong lowpass filtering of both voltage and current waveforms is a good idea to reduce high-frequency noise. But it is super important that identical filters be applied to both voltage and current to prevent group delay problems.

The voltage and the current really should get measured at exactly the same time. But if your sample rate is high enough, you might get by just taking the average of two sequential current measurements. For instance:

#46—current
#47—voltage
#48—current
#49—voltage
#50—current

. . . and then multiply voltage #47 times the average of current #46 and current #48. Similarly, multiply voltage #49 times the average of current #48 and current #50, and so on.

A PIC is your obvious choice for lowest-cost AC power measurement calculations. Suitable current sensors might include a current transformer (Amecon is one better source), Hall-effect sensors, clamp probes, or measuring the voltage drop across a suitable small series resistor.

## The New Stuff

As we already found out back in June, 1997 (MUSE112.PDF), those ordinary cheap voltmeters and ammeters are totally useless to measure real AC power. Such meters measure average rather than true rms. They all lie like a rug, because their "answer" is so highly waveshape dependent. Instead, here are several of the latest new developments in low-cost accurate AC power measurement:

**True rms meters**—The costs for digital or analog meters with a true rms ability is dropping dramatically. Even Radio Shack now resells $79 digital voltmeters that can provide true rms. A true rms meter gives you total waveform and full harmonic independence, as long as you stay under acceptable crest factors, which at least gets rid of the really stupid measurement mistakes. But note that since you don't know the phase angle, you still cannot multiply rms volts times rms amps to get power.

**Digital storage scopes**—The latest of DSOs and many computer data-acquisition plug-ins now permit you to multiply input values together and display the results, which lets you directly view those power waveforms of Fig. 1. Doing that was once horrendously difficult to do.

**Analog Devices AD7750**—This new chip family was originally intended as a $2.50 solid-state replacement for a European 50-hertz power meter. Inside you will find a pair of high-accuracy A/D converters, a digital multiplier, a digital-to-frequency converter, and even stepper motor drivers for a mechanical totalizer.

Some external filter parts seem to be required for 60-hertz operation. The output frequencies of only a few hertz are surprisingly low, so they seem best at averages rather than for cycle-by-cycle measurements.

Their data sheet does mention crest factors of two, which suggests that it may not do all that great on stranger waveforms. The European method around high crest factors is to simply make them illegal, which is what IEC standard 555-2 is all about and why there is so much excitement over those new power-factor correction chips and

circuits. Analog Devices Website is found at www.analog.com.

**Maxim MAX125**—This is a brand new simultaneous multi-channel A/D converter. It is specifically designed for power meters, motor controls, and for power-factor monitoring. There are eight analog inputs that are routed to a 4PDT selector switch and then input to four simultaneous A/D converters. Fourteen bit conversion is provided in three microseconds, by using the circuit of Fig. 3. An external clock is needed. Its typical value is 16 MHz.

There are fourteen parallel data outputs, the lower four of which are used as bi-directional address inputs to program one of eight conversions plus a power down. The choices are A or B sides of one through four channels of conversion. It takes three microseconds to do the one-channel conversion and twelve microseconds for a four-channel conversion.

There are four control inputs of chip select, read enable, write enable, and conversion start. There's also a "conversion-done" output normally used as an interrupt.

After conversion is done, the first read-enable reads out channel 1 as parallel data. The next one outputs channel 2, then channels 3 and 4 in order.

For single-phase power, you'd normally only select a single side of channel 1 for current and channel 2 for voltage. The full four channels may be required for three-phase power systems or exotic motor controls.

Note that this chip only measures the input values for you, doing so accurately and simultaneously. Your host PIC or whatever has to do the math to calculate actual instantaneous power.

The interface to a PIC or other microcontroller is fairly simple. An external data latch may be needed in some systems. Evaluation kits and free chip samples are available. Maxim's Website can be found at www.maxim-ic.com.

**Digitest DT500**—This is a unique home-power monitor that I've been testing. Using a $399 list package about the size of a box of cereal, you can monitor 120/240 volt AC appliances for the voltage, current, kilowatt hours, and duty cycle, plus actual electricity costs in dollars and cents.

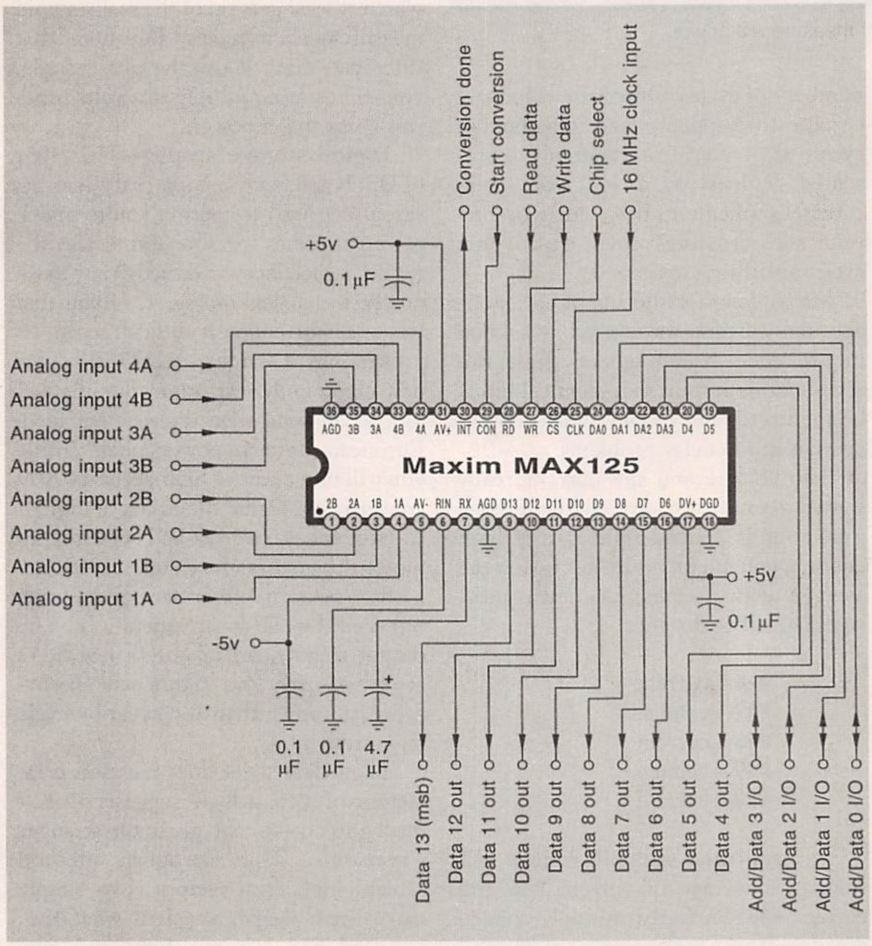


**FIG. 3**—THE NEW MAXIM MAX125 lets you simultaneously sample voltage and current. This is a crucial first step in digital power measurement. A microcontroller does the actual multiplication.

## AC POWER-MANAGEMENT RESOURCES

**Amecon**
1900 Chris Ln.
Anaheim, CA 92805
(714) 634-2220

**Circuit Cellar Ink**
4 Park St. #20
Vernon, CT 06066
(203) 875-2751

**Digitest Services**
4518 Chateau Dr.
Albany, GA 31707
(912) 883-4047

**EPRI Journal**
PO Box 10412
Palo Alto, CA 94303
(415) 855-2000

**Electronics Now**
500 Bi-County Blvd.
Farmingdale, NY 11735
(516) 293-3000

**Energy Depot**
1797 Northeast Expressway #100
Atlanta, GA 30329
(404) 633-9099

**Home Automator**
2258 Sandy Lane
Mebane, NC 27302
(910) 578-9519

**Home Power**
PO Box 520
Ashland, OR 97520
(800) 707-6585

**Maxim**
120 San Gabriel Dr.
Sunnyvale, CA 94086
(800) 998-8800

**Remote Measurement**
2633 Eastlake Ave. #200
Seattle, WA 98102
(206) 328-2255
www.measure.com

**Rocky Mountain Institute**
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Snowmass, CO 81654
(970) 927-3851

**Zomeworks**
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**Card Technology**
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(312) 913-1334

**Data Storage**
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(603) 891-0123

**Forming & Fabricating**
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**Mabry Publishing**
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Seattle, WA 98103
(206) 634-1443

**Magnet Applications**
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Horsham, PA 19044
(800) 437-8890

**muRata-Erie**
2200 Lake Park Dr.
Smyrna, GA 30080
(800) 731-9172

**Precision Navigation**
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(415) 962-8777

**Roberts Electric**
311 N Morgan St.
Chicago, IL 60607
(312) 829-1365

**Science/AAAS**
1333 H St. NW
Washington, DC 20005
(202) 326-6400

**Surplus Direct**
Box 2000
Hood River, OR 97031
(800) 753-7877

**Synergetics**
Box 809
Thatcher, AZ 85552
(520) 428-4073

**Don Thompson Seminars**
20650 Prairie St.
Chatsworth, CA 91311
(800) 423-5400 x2537

You can plug an appliance or other load into the back of the unit, use an accessory snap-around current probe, or directly input any custom test voltage that is related to current. You can very quickly find out that your refrigerator is costing you $19.37 per month, your freezer gobbles $9.78, and so on.

Around 3600 current and voltage samples per second are taken in this Intel 8751 based device.

The DT500 certainly does what it claims to, and sure is a lot of fun to play with, especially for doing your own home-energy inventory. On the other hand, the ergonometrics aren't all that great, the LCD desperately needs to be backlit, the cents per kWh cost entry is klutzy, and there's zero I/O provision for data capture, record keeping, or for any history plotting. In addition, some sort of a wireless current sensor with a 35-foot range sure would be handy.

**The Remote Measurement Systems Power Sentry**—This is a neat little infrared sensor that sticks to the glass of an ordinary power meter and then counts every time the black mark on the disk comes around. The $79 device is not only allowed by certain power companies, but it is actually approved of and strongly encouraged. A companion ADC-1 interface and control software for Mac or PC lets you plot a month's power use in half-second intervals.

I've gathered a few preliminary sources for AC-power measurement and home-energy management as this month's resource sidebar. More on rms power measurement in MUSE112.PDF on www.tinaja.com.

### New Tech Lit

From Logic Devices there's a new *Power of Signal Processing* data book. In it, you will find special video-filter, alpha mixer-channel, and histogram chips. From muRata-Erie comes a new *RF and Microwave Products Catalog* in which you'll find bunches of ceramic resonator and surface acoustic wave (SAW) devices.

Texas Instruments has come out with a pair of new CD-ROM data books entitled *InfoNavigator* and *The Future of DSP Technology*. Also from TI are data sheets on their new low-cost TSL253 light-to-voltage converter.

An item on the use of DNA computing to solve a major math problem appears on pages 446-449 of *Science* for October 17, 1997. Volume 278.

A booklet on higher-performance permanent magnets is available from Magnet Applications. Some low-cost hygrometers are resold by Klockit. Hydraulic bargains can be found at Roberts. Superb laser-printer service seminars, and printer maintenance manuals are offered by Don Thompson.

Richard Grier has a new *Visual Basic Programmer's Guide to Serial Communications*, his useful text on low-level Windows communications access. It is published by Mabry. From Lindsay Publications comes two volumes of their "new-old" 1906 reprint "Experimental Science" series; those are *Elementary Practical Physics* and *Experimental Physics.*

Featured trade journals for this month are *Data Storage* for hard-disk insiders, *Forming & Fabricating* for sheet metal, and *Card Technology* on smart cards.

The latest and finest version of Adobe Acrobat is newly available for $49 from the Academic Software division of Surplus Direct. Acrobat includes the powerful Distiller 3.01 program which makes an outstanding host-based PostScript-as-language computer. More details on the power of raw PostScript computing can be found in DISTLANG.HTML and also in POSTFLUT.PDF on my Guru's Lair at www.tinaja.com.

For nearly all individuals and all small-scale startups most of the time, an involvement with patents is likely to end up as a net total loss of time, energy, money, and sanity. Find out why in my *The Case Against Patents* package per my nearby Synergetics ad.

Plus the usual reminder about my Guru's Lair Website at www.tinaja.com. Some of the latest additions include new information on virtual reality, surplus and auction details, and newly expanded Bezier cubic spline coverage.

As usual, most of the mentioned items should appear in our Names & Numbers or AC Power-Management Resources sidebars. Always check there first before calling our US technical helpline. EN

SUPPLEMENT TO ELECTRONICS NOW MAY 1998

# Electronic SHOPPER

# BLOWOUT! TIMELINE INC. BLOWOUT!

## Over 11 years and 29,000 customers and still growing

### LIQUID CRYSTAL DISPLAYS

**240x64 dot LCD with built-in controller.**
AND 4021ST-EO. *Unit is EL back-lit.* $59.00 or 2 for $109.00 or
OPTREX. DMF5005 *(non back-lit)* $49.00 or 2 for $89.00
20 character x 8 line
7¼L x 2¼H
*The built-in controller allows you to do text and graphics.*

**Alphanumeric—parallel interface**

| | | | | | |
|---|---|---|---|---|---|
| 16x1 | $7.00 | 20x2 | $10.00 | 32x2 | $8.00 |
| 16x1 (lg. char.) | $10.00 | 20x4 | $15.00 | 40x1 | $8.00 |
| 16x2 | $7.00 | 20x4 (lg. char.) | $10.00 | 40x2 | 2 for $20.00 |
| 16x2 (lg. char.) | $10.00 | 24x2 | $10.00 | 40x4 | $20.00 |
| 16x4 | $15.00 | 32x4 | $10.00 | 4x2 | $5.00 |

5V power required • Built-in C-MOS LCD driver & controller • Easy "microprocessor" interface • 98 ASCII character generator • *Certain models are backlit, call for more info.*

**Graphics and alphanumeric—serial interface**

| size | Mfr. | price | size | Mfr. | price |
|---|---|---|---|---|---|
| 640x480 (backlit) | Epson | $25.00 | 480x128 | Hitachi | $10.00 |
| 640x400 (backlit) | Panasonic | $20.00 | 256x128 | Epson | $20.00 |
| 640x200 | Toshiba | $15.00 | 240x128 (backlit) | Optrex | $20.00 |
| 480x128 (backlit) | ALPS | $10.00 | 240x64 | Epson | $15.00 |
| | | | 160x128 | Optrex | $15.00 |

**6" VGA LCD** 640X480, Sanyo LMDK55-22 **$25.00**

### LASER PRODUCTS

**HeNe Laser Head** (10Mw max. output) TEMOO, 15.5" long MFG: NEC **$89.00**
**Laser Power Supply** (for HeNe tube) **$79.00**

**LASER SCANNER ASSEMBLY $19.00**
Assembly intended for a laser printer. Includes laser diode, polygon motor (6 sided) and misc. optics and lenses.

**LASER DIODE** (5mW) with collimator **$20.00**

***VISIBLE LASER DIODE:*** 5mw at 670nm **$15.00**
Index guided. Threshold current 40 ma typical.

**3 and 4mW, 1,300nm LASER DIODES, 5.6mm package, $15.00**
**Mitsubishi Electric part number ML701BIR-E21A, General specs are:**
1. Vop=1.25, Beam Divergence 25.6° x 28.6°; 2. Tc=24°C, Iop=19 to 20mA, ITH=10.7mA; 3. Wavelength range between 1,280nm and 1,330 nm

**POLYGON MOTOR UNIT & DRIVER $69.00**
Ten-sided first surface mirror mounted on an armature that spins at 125 revolutions per second yielding a beam sweep rate of 1250 sweeps per second. The driver for the polygon unit requires 24 volts and plus and minus 12 volts to operate. There is also an f-theta lens in front of the polygon scanning mechanism with a three inch diameter. Great for optical experiments, etc. Very high quality units. (MFR: JAPAN ELECTRONICS)

### POS & BAR CODE

**MAGNETIC CARD READER $25.00**
Includes: • 20 character dot matrix display with full alpha-numeric capability • keypanel with full alpha-numeric entry • separate 7.5 VDC/0.5 Amp power supply • standard telephone interface extension cord • lithium battery and flat-cone speaker.

HP bar code wand (HBCS 2300)....................$25.00

### POWER SUPPLYS

**SWITCHING POWER SUPPLYS $12.00 or 2 for $20.00 115/230 Volts**
**73 WATT** (2) 4 pin power connectors attached • Dim: 8.5" L x 4.5" W x 2" H
Output: +5V @ 2-9.75, A, +12V @ 0-1.5 A, -5V @ 0-0.4 A, -12V @ 0-0.5 A
**60 WATT** Dim: 8¾ x 4¼ x 3 • Output:5V @ 6A + 12V @ 1A - 5V @ 1A - 12V @ 1A

### CHARGE COUPLED DEVICES

**"The Spy In The Sky" $29.00** **MATRIX TYPE**

**Thomson 576X550 pixel CCD**
400-1,100nm resolution and responsivity. **$500.00 Original cost device**

**Sony CCD Imager - designed for black and white composite video cameras. Picture elements: 384 (H) x 491 (V) $29.00**
Chip size 10.7 (H) x 9.3 (V) mm² • Unit cell size 23.0 (H) x 13.4 (V) um². Ceramic 24 pin DIP package • Mfr: Sony, Part# 016AL

**4096 element CCD $15.00**
**1024 element CCD $10.00** **LINEAR TYPE**
**2048 element CCD $10.00 • 1728 element CCD $10.00**

### MISCELLANEOUS

**ADAPTEC 4070A (RLL) OR 4000A (MFM), SCSI Controller, your choice $25.00**

**IBM 370 option XT and AT emulation boards $25.00**

### MONITORS

**Non-Enclosed TTL**
Comes with pinout. 12V at 1.4 Amp input • Horizontal frequency 15Khz. • Ability to do 40 and 80 column.
**5 inch Amber $25.00 • 7 inch Amber $25.00**
**9 inch Amber or Green $25.00**

**5" COLOR MONITOR $39.00**


• Flat Faceplate • 320 x 200 Dot Resolution • CGA & Hercules Compatible
• 12 VDC Operation • 15.75 KHz Horiz. Freq. • 60 Hz Vert. Sync. Freq.
• Open Frame Construction • Standard Interface Connector • Degaussing Coil included • Mfr. Samtron

**9" COLOR SVGA MONITOR $249.00**
Fully Enclosed – Tilt and swivel type.

### HACKER CORNER

**EMBEDDED 486 COMPUTER $99.00**
Complete enhanced Intel 486SX-33 based computer in ultra small (9-7/8L x 6-5/8W x 3-1/8H) case. Ideal for embedded operations or as a second computer. Features include: • One 16 bit ISA slot • 3 serial ports plus dedicated printer port • Parallel optical coupled adapter port • Built in IBM PC/AT keyboard port • On board VGA video and port • Uses standard SIMM up to 32 MB • BIOS is PC/AT compatible
Unit has a backup Ni-Cd battery system in case of power failure (5 min. backup time) and lockable front cover to prevent floppy drive access. Mounting / interface provisions for standard 3.5" laptop floppy and 2.5 inch hard drives. Comes with very comprehensive manual.

**Encased Spread Spectrum RF Modem $199.00**
The ProxLink Radio Module is a small communication device which replaces cables between RS-232 devices with wireless RF (Radio Frequency) technology. Attaching a pair of ProxLinks to any two devices with three wire asynchronous RS-232 ports allows wireless data transmittal at rates up to 19.2 Kbaud (full duplex) over a range of 500 - 800 feet. Modules use 900 MZ spread spectrum radio for communication which does not require an FCC site license. A variety of configuration information (radio channel, baud rate, serial port configuration, etc.) can be programmed into module's non-volatile memory by host PC to provide compatibility and avoid overlapping systems. Configuration changes are supported by menu driven, on-board software. Commonly used Terminal Emulation software and transfer protocols can be used for configuring modules and transferring data between computers. ProxLinks require only 6-9 VDC (350 mA), RS-232 (9 pin sub - D) interface, and small (~ 4") whip antenna for operation. Unit size is 4.0" x 6.5" x 0.75". Installation schematics and application details available.

**US made Micronics 486 VLB ALL in ONE $39.00 or 2 for $69.00**
motherboard, supports 3.4 or 5V CPU, at either 25 or 33 mhz basic clock. Can use AMD or Intel from 486SX25 thru 486DX4-100 to HOT new AMD 5X86-133 cpu. On board SVGA video. On board 1 meg video ram expandable to 2 meg with ATI Mach 2 chip set. On board 2 high speed serial ports, 1 printer port, floppy and IDE hard drive controller. On board 256K cache. Uses 72 pin simm memory. Landmark speed rating of 479 with AMD chip.
Board will not fit standard All in One case because of non standard location of riser board. VLB riser board is included with motherboard.

**COLOR CCD CAMERA $149.00**
• 12 VDC • 1/3-inch, CCD area image sensor • 514 (horizontal) x 491 (vertical) • 2:1 interlaced • 15.734 kHz (horizontal), 59.94 Hz (vertical) • 330 horizontal and 350 vertical lines • 10 lx • 1V, NTSC signal format • Lens: 1/3-inch, fixed focus (F:2.8 f:5.6) • Dimensions: (W) 67 (2.63) x (H) 34 (1.45) x (D) 112.6 (4.43)

**SONY Miniature Color LCD Display (LCX005BKB) $29.00**
• 1.4 CM (0.55 inch) Diagonal Full Color Display • Built In Horizontal and Vertical Drivers • Delta Dot Pattern for High Picture Quality - 537 dots (H) x 222 dots (V) • Compatible with NTSC & PAL Format and Sync Inputs • 12 VDC Operation with -1 to +17 V RGB Signal and Driver Input Voltage • Excellent Display for Virtual Reality Projects, Viewfinders, and Miniature Test Equipment Displays • Pin Outs and Specification Included • Unit Requires Clock, Synchronization and Video

**CELL SITE TRANSCEIVER $49.00 2 for $89.00**
These transceivers were designed for operation in an AMPS (Advanced Mobile Phone Service) cell site. The 20 MHz bandwidth of the transceiver allows it to operate on all 666 channels allocated. The transmit channels are 870.030-889.980 MHz with the receive channels 45 HMz below those frequencies. A digital synthesizer is utilized to generate the selected frequency. Each unit contains two independent receivers to demodulate voice and data with a Receive Signal Strength Indicator (RSSI) circuit to select the one with the best signal strength. The transmitter provides a 1.5 watt modulated signal to drive an external power amplifier. channel selection is accomplished with a 10 bit binary input via a connector on the back panel. Other interface requirements for operation are 26 VDC (unregulated) and an 18.990 MHz reference frequency for the digital synthesizer. The units contain independent boards for receivers, exciter, synthesizer, tunable front end, and interface assembly (which includes power supplies and voltage-controlled oscillator). Service manual, schematics and circuit descriptions included.

**Encased Black & White Composite CCD Camera with Adapter**
**IR viewing to 1000 nm 7 ½ L x 2 ⅞ W x 1 ¾ H**
Comes complete with CCD camera, mounting nut on bottom of casing, 12VDC power supply. Excellent low light capability, standard RCA NTSC video out. **$89.00**
**Great for: entryway security/remote monitoring, video conferencing/desktop video conferencing** **2 for $159.00**
This miniature camera is perfect for multimedia computer applications as well as security and surveillance. NTSC output allows use with all popular video digitizing boards for Apple Macintosh and Microsoft video for Windows. Connects directly to any composite monitor or VCR with "video" input. Its razor-sharp wide-angle lens focuses from two inches to infinity and its state-of-the-art CCD technology accurately captures 16 level grayscale images for Quick Time movies and still pictures. Records at 30 frames per second and 260 lines resolution with excellent low light capability. Uses 12VDC (adapter supplied) and standard RCA cable.

**2539 W. 237th Street, Bldg. F, Torrance, CA 90505**
Order desk only: **USA: (800) 872-8878 CA: (800) 223-9977**
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Minimum Order: $20.00. Minimum shipping and handling charge $5.00. We accept cashiers checks, MC or VISA. No personal checks or COD's. CA residents add 8.25% sales tax. We are not responsible for typographical errors. All merchandise subject to prior sale. Phone orders welcome. Foreign orders require special handling. Prices subject to change without notice. 20% restocking fee for returned orders.

CIRCLE 275 ON FREE INFORMATION CARD


CIRCLE 270 ON FREE INFORMATION CARD

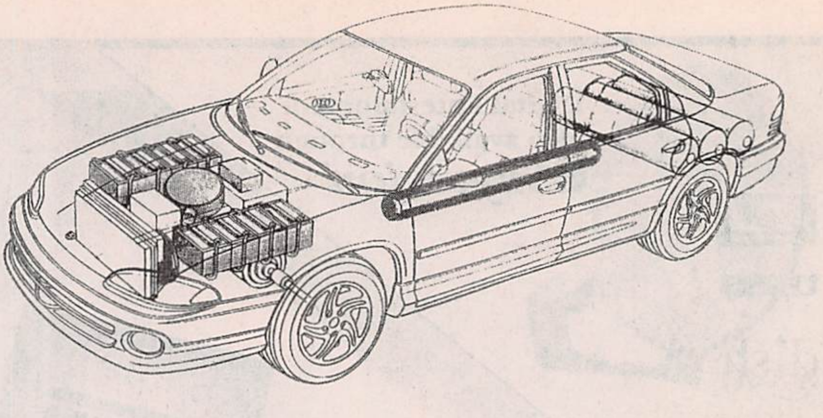
## FUEL-CELL VEHICLES

*(continued from page 53)*

cient fuel for a very respectable 250-mile range. Mercedes-Benz has said it plans to produce 100,000 fuel-cell powered A-Class cars by 2005.

Not only smaller and more efficient, the new reformer process gives improved performance and dynamic response. According to Mercedes-Benz, when you press the throttle, 90% percent of the power is available in two seconds. That puts fuel-cell vehicles on a par with conventional gasoline- or diesel-powered automobiles. The NECAR 3 is virtually emission-free. Neither nitrogen oxides nor soot particles are produced during the reformulation process or in the fuel cell itself.

In Japan, Mazda has demonstrated a 20-kW PEM fuel-cell engine and Toyota unveiled its first fuel-cell vehicle with a 20-kW PEM system in 1996 with a second-generation version planned for this year. Honda is also working on a fuel-cell vehicle. Renault, in collaboration with Volvo, is working on its FEVER (Fuel Cell Vehicle of Extended Range). Reportedly, BMW, Nissan, Volkswagen, Siemens, Toshiba, and others have fuel-cell projects on the drawing board.



*Hydrogen would be stored on-board in the Chrysler-Pentastar direct-hydrogen PEM Fuel-Cell Program vehicle. The PEM fuel-cell system would replace the internal combustion engine. (Fuel Cells 2000)*

Will you see a fuel-cell car down at your local dealer soon, or even within a few years? Probably not. Besides bugs still to be worked out, there is the matter of cost. Fuel cells are still many times more expensive than the most sophisticated and powerful dual-overhead camshaft, 48-valve V-12 running on ordinary gasoline. Also, automakers are understandably reluctant to cast aside their huge investment in the internal-combustion engine for a new technology that would require another huge investment for new manufacturing facilities and whose consumer acceptance is still an unknown quantity. Still, fuel-cell technology might just represent the best current option to replace the internal-combustion engine. Ω

## NATIONAL TECHNICIAN'S DAY

*(continued from page 56)*

To qualify for Journeyman certification, a technician must have four years or more of education and/or experience in electronics. He or she must also have passed the Associate CET exam and must take and pass a 75-question Journeyman Option exam on one of several areas of specialization. Those areas include: Audio, Biomedical, Communications, Computers, Consumer Products, Industrial, Radar, Video, and Appliance Servicing. A technician may also use the Associate certification issued by the Electronics Technicians Association International (ETA) to qualify for any of the Journeyman options.

If you have already attained Journeyman certification, you can take one of several 25-question Endorsement exams designed to prove advanced expertise in a specific field. Currently, Endorsement exams are available in Camera/ Camcorder/8mm, Computer Monitor, Motor Control, VCR, Audio, CD/ VLD, and Digital Communications.

The fee structure is as follows: For the Associate exam, the fee is $30. For any Journeyman Option, the fee is $35. If both the Associate and a Journeyman Option exam are taken at the same time, the fee is $50. Each test has a two-hour time limit, and a score of 75% or better is required to pass. For the Journeyman Endorsement exam, the fee is $35, there is a one-hour time limit, and a 75% score is required to pass the exam.

ISCET test examiners are also qualified to administer FCC element tests. The fees vary depending on which elements are taken.

**To Commemorate T-DAY.** ISCET invites all technicians to celebrate National Electronics Technicians Day during the Week of April 21 through April 25, 1998, which has been designated T-WEEK. If you are planning to take the CET exams, now is the time as during T-WEEK, ISCET's network of Certified Test Administrators will be providing opportunities for interested technicians to obtain their certification. Whether you are interested in completing your Associate, Journeyman , or Journeyman Endorsement Certificate; gaining continuing education units; or want to sit for one of many FCC elements, contact one the examiners in the Volunteer Examiners box that accompanies this article. Those test administrators are dedicated to the continued growth of the CET program and anxiously await hearing from you. For more information on the CET program, visit ISCET's home page located at www.iscet. org. Ω

# EARN MORE MONEY!

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ADDRESS ____________________
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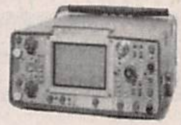
## TEKTRONIX 465M SCOPE



**AN/USM-425** militarized DC-100 MHz dual-trace oscilloscope with 8x10 CM display. Deflection 5 mv to 5 V/div in 10 calibrated steps, 1-2-5 sequence + vernier. Modes: TRIG View, 20 MHz BW, CH 1, ALT, Add, Chop, CH 2 or X-Y. Sweep 0.05 usec - 0.5 s/div in 22 steps + vernier; delay 0.05 us - 50 ms/div. Also X10 magnifier, adjustable handle, cover & manual coy. 100-132/200-264 VAC 48-440 Hz; 7x1.7x21.5, 32 lbs. **USED-CHECKED, $475.00**

## 0-135 VDC 15 A Supply

**PP-1459A BATTERY CHARGER,** used to charge storage batteries; produces unregulated 0-135 VDC 15 amp output from 115/230 VAC 50-60 Hz 15 amp input. Has 2.5" dia meters 0-150 VDC and 0-20 amps DC, Coarse & Fine 12-step controls, plus 115/230 V input selector. Input - Output each have circuit breaker; with power cord. 12x11x12, 60 lbs sh. **Used, $49.50**

## Lifting Body Balloon

Distress-orange inflatable "manta ray" shaped balloon measures about 8 feet nose-to-tall, wing-tip-to-wing-tip; 3 feet at thickest. Intended to be helium-filled to raise a wire antenna for air-sea rescue transmitter. Slight breeze lifts it much easier than round balloon even when air-filled. Nice experimental; 3 lbs sh. **#SEB-42-ALV, unused, $25.00**

## ANTENNA TETHER WIRE

306 FOOT SPOOL of vinyl-covered braided #22-size antenna wire intended for use with above kite or with balloon; usable as long wire antenna also. On spool; 3 lbs sh. **#SEB-400X3, unused, $12.95**

**Prices F.O.B. Lima, Ohio. VISA, MASTERCARD Accepted.**
**Allow for shipping charges. Write for latest Catalog.**
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**Complete Ruby Laser Assembly less than $300**
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# Check Out What We Have To Offer:

## Fantastic DMM Offer!!!


Don't let the price fool you. This meter is a digital multimeter designed for engineers and hobbyists. Equipped with 5 functions and 19 ranges. Each test position is quickly and easily selected with a simple turn of the FUNCTION/RANGE selector rotary switch.

**$19.00** any qty

**General** — **Rubber Boot Included**

*Display:* 3-1/2 Digit LCD, 21mm Figure Height with Automatic Polarity
*Overrange Indication:* 3 Least Significant Digits Blank
*Temperature for Guaranteed Accuracy:* 23 C 5 C RH<75%
*Temperature Ranges:*
Operating: 0 C to 40 C (32 F to 104 F)
Storage: -10 C to 50 C (14 F to 122 F)
*Power:* 9V Alkaline or Carbon-Zinc Battery(NEDA1604)
*Low Battery Indication:* BAT on Left of LCD Display
*Dimensions:* 188mm long x 87mm wide x 33mm thick
*Net Weight:* 400g

**DC Voltage (DCV)**

| Range: | Resolution: | Accuracy: |
|---|---|---|
| 200mV | 100 V | |
| 2000mV | 1mV | (1%rdg+2dgts) |
| 20V | 10mV | |
| 200V | 100mV | |
| 1000V | 1V | |

*Maximum Allowable Input:* 1000V DC or Peak AC.

**DC Current (DCA)**

| Range: | Resolution: | Accuracy: |
|---|---|---|
| 200 A | 100nA | |
| 2000 A | 1 A | (1.2%rdg+2dgts) |
| 20mA | 10 A | |
| 200mA | 100 A | (1.2%rdg+2dgts) |
| 10A | 10mA | |

*Overload Protection:* mA Input. 2A/250V fuse.

**Resistance (Ω)**

| Range: | Resolution: | Accuracy: |
|---|---|---|
| 200Ω | 100mΩ | |
| 2000Ω | 1Ω | |
| 20KΩ | 10Ω | (1.2%rdg+2dgts) |
| 200KΩ | 100Ω | |
| 2000KΩ | 1KΩ | |
| 20MΩ | 10KΩ | (2%rdg+10dgts) |

*Maximum Open Circuit Voltage:* 2.8V

**Diode Test**
Measures forward voltage drop of a semiconductor junction in mV test current of 1.5mA Max.

**ohFE Test**
Measures transistor hFE.
*Frequency Range:* 45Hz-450Hz
*Maximum Allowable Input:* 750V rms
*Response:* Average Responding. Calibrated in rms of a Sine Wave.

**AC Voltage (ACV)**

| Range: | Resolution: | Accuracy: |
|---|---|---|
| 200V | 100mV | (1.2%rdg+10dgts) |
| 750V | 1V | |

| CAT NO | DESCRIPTION | PRICE |
|---|---|---|
| 9300G | Rugged High Quality DMM with Rubber Boot | $19.00 |

## 20 AMP Switching Power Supply

**$99.00** any qty

A very special Circuit Specialists offer. This 20 amp continuous switching power supply is available at this fantastic low price!

Specifications
Input Voltage: AC 110V +/- 15%, 50Hz/60Hz
Output Voltage: DC9V 15V variable
Polarity: Negative ground
Current (13.8v): 25A peak, 20A continuous
Overvoltage Protection
Cooling fan inside chassis

| CAT NO | DESCRIPTION | PRICE |
|---|---|---|
| SPS-1020G | 20 Amp Switching Power Supply | $99.00 |

## Developer

This product is used as the developer on our positive photo-resist printed circuit boards. Includes instructions. 50 gram package, mixes with water, makes 1 quart.

| CAT NO | DESCRIPTION | PRICE EACH 1 | 10 | 25 |
|---|---|---|---|---|
| POSDEV | Positive Developer | $ .95 | $ .80 | $ .50 |

## Etching Chemicals/Ferric Chloride

A dry concentrate that mixes with water to make 1 pint of etchant, enough to etch 400 sq. inches of 1oz board.

| CAT NO | DESCRIPTION | PRICE EACH 1 | 5 |
|---|---|---|---|
| ER-3 | Makes 1 pint | $3.50 | $2.75 |

## Positive Photo Resist Pre-Sensitized Printed Circuit Boards

These pre-sensitized printed circuit boards are ideal for small production runs. They provide high resolution and excellent line width control. High sensitive positive resist coated on 1oz. copper foil allows you to go direct from your computer plot or art work layout. No need to reverse art.

**Single-Sided, 1oz. Copper Foil on Paper Phenolic Substrate**

| CAT NO | DESCRIPTION | PRICE EACH 1 | 10 | 50 |
|---|---|---|---|---|
| PP101 | 100mm x 150mm/3.91" x 5.91" | $2.55 | $1.90 | $1.70 |
| PP114 | 114mm x 165mm/4.6" x 6.6" | 2.98 | 2.45 | 1.98 |
| PP152 | 150mm x 250mm/5.91" x 9.84" | 5.40 | 3.98 | 3.60 |
| PP153 | 150mm x 300mm/5.91" x 11.81" | 6.15 | 4.48 | 4.10 |
| PP1212 | 305mm x 305mm/12" x 12" | 12.78 | 10.65 | 8.52 |

**Single-Sided, 1oz. Copper Foil on Fiberglass Substrate**

| CAT NO | DESCRIPTION | PRICE EACH 1 | 10 | 50 |
|---|---|---|---|---|
| GS101 | 100mm x 150mm/3.91" x 5.91" | $ 3.90 | $2.98 | $2.60 |
| GS114 | 114mm x 165mm/4.6" x 6.6" | 4.80 | 3.49 | 3.20 |
| GS152 | 150mm x 250mm/5.91" x 9.84" | 8.69 | 5.98 | 5.78 |
| GS153 | 150mm x 300mm/5.91" x 11.81" | 10.20 | 7.20 | 6.80 |
| GS1212 | 305mm x 305mm/12" x 12" | 18.88 | 15.73 | 12.59 |

**Double-Sided, 1oz. Copper Foil on Fiberglass Substrate**

| CAT NO | DESCRIPTION | PRICE EACH 1 | 10 | 50 |
|---|---|---|---|---|
| GD101 | 100mm x 150mm/3.91" x 5.91" | $ 5.07 | $3.68 | $3.38 |
| GD114 | 114mm x 165mm/4.6" x 6.6" | 5.95 | 4.29 | 3.99 |
| GD152 | 150mm x 250mm/5.91" x 9.84" | 10.47 | 7.39 | 6.98 |
| GD153 | 150mm x 300mm/5.91" x 11.81" | 11.95 | 8.69 | 8.30 |
| GD1212 | 305mm x 305mm/12" x 12" | 22.09 | 18.35 | 14.68 |

## Etching Tank

This handy etching system will handle PC boards up to 8" x 9", two at a time. Ideal for etching your PCB's! System includes an air pump for etchant agitation, a thermostatically controlled heater for keeping etchant at optimum temperature and a tank that holds 1.35 gallons of etchant. A tight fitting lid is also supplied to prevent evaporation when system is not being used. Typical etching time is reduced to 4 minutes on 1oz. copper board!

**REDUCES ETCHING TIME!**

| CAT NO | DESCRIPTION | PRICE |
|---|---|---|
| 12-700 | Etch Tank System | $37.95 |

## 1/3" CCD Board Cameras

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### World's Smallest B&W Board Cameras

**Specifications**

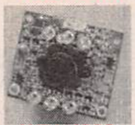
| | |
|---|---|
| Image Pick-Up Device | 1/3" CCD area Sensor |
| Picture Elements | EIA=512(H) x 492(V) |
| Pixel Pitch | EIA=9.6UM (H) x 7.5UM (V) |
| Scanning System | 2 : 1 Interlace |
| Scanning Frequency | EIA=525 lines, 60 field/sec (II) 15.750 KHz x 60 HK |
| Resolution | 430 Lines |
| Minimum Illumination | 0.03 LUX |
| S/N Ratio | 45DB |
| Lens Mounting | 4.3mm standard, 5mm pinhole |
| Video Output | 1.0 VP-P/75OOHM composite signal |
| Power Requirement | 8-12 VDC (9VDC standard) |
| Power Consumption | 100mA |
| Operating Temperature | -20C -+ 70 C RH 95% Max |
| Storage Temperature | -40C -= 85 C RH 95% Max |
| Audio Pick-Up Sensitivity | -60 DB (0DB = 1B/UBAR. 1KNZ) |
| Audio Frequency Range | 20 Hz to 20KHz |
| Audio S/N Ratio | More than 35DB |
| Audio Output Level | 1VP-P/600 OHM |

**Dimensions**

| | |
|---|---|
| WDP-2000 | 30mm (H) x 30mm (W) |
| WDS-2005 | 30mm (H) x 30mm (W) |
| WDI-4000 | 44mm (H) x 30mm (W) |

WDP-2000

WDS-2005



WDI-4000

| CAT NO | DESCRIPTION | PRICE EACH 1 | 5 |
|---|---|---|---|
| WDP-2000 | 1/3" B&W Pinhole Lens with Audio | $89.00 | $77.00 |
| WDS-2005 | 1/3" B&W Standard Lens with Audio | 89.00 | 77.00 |
| WDI-4000 | 1/3" B&W Infra-RED (no audio) | 89.00 | 77.00 |
| WDPH-55BW | Plastic Housing Option for B&W Board Cameras (WDP-2000 & WDS-2005 ONLY) | 13.00 | 12.00 |

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4.7uF 47uF
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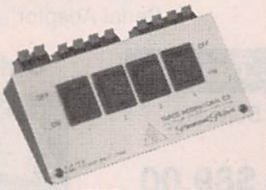

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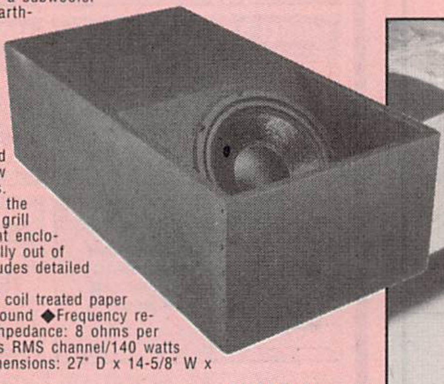

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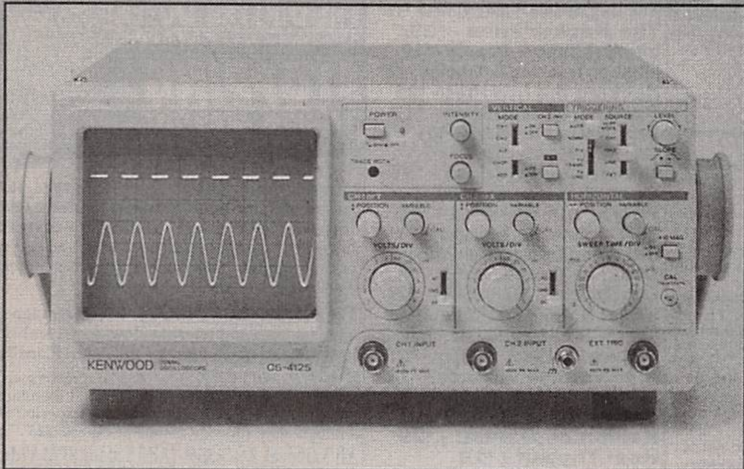




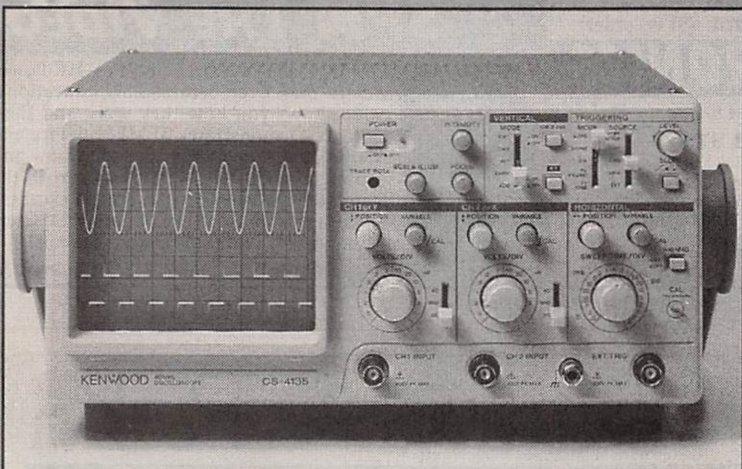






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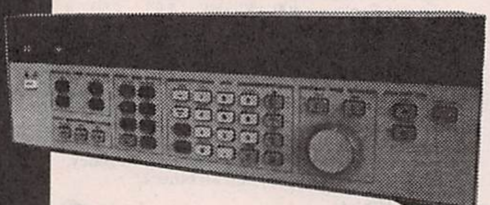

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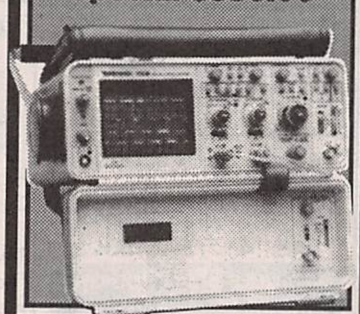

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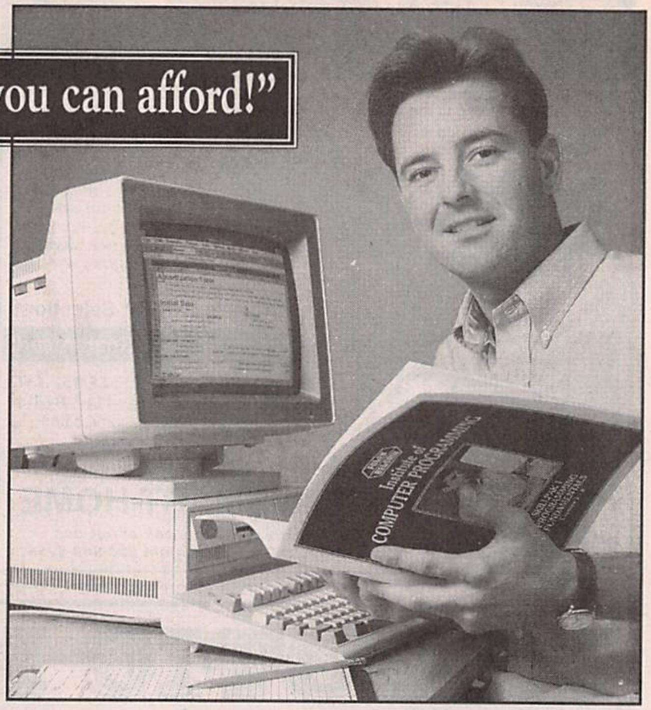


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**Dick Manning - Dicks Electronics - Hartland WI 414-367-8339**
The ease & speed of component removal greatly increases productive time. The SMD kit makes SMD removal a breeze, even for inexperienced Techs.

**George Hefner - Hefner Electronics - Coleridge NE 402-283-4333**
Being a one-men service center, I hesitated to spend the money on a desoldering tool , however all that changed when I nearly ruined a $400 computer logic board. It has cut my desoldering time by 50%

**FREE TRIAL**
Available on Request

**Sale Price $395.00**

*Price includes stand worth $25.00 one extra filter, and two tip cleaners.*

**Don Cressin - Certified Electronics Service - Ellicott City MD 301-461-8008**
We have obtained excellent results with the SC7000Z including repairing high density U/V tuners. It is one of the best purchases we have made.

**Doug Pettit - LuRay Electronics - LuRay VA 703-743-5400**
We found that the SC7000Z not only saves money vs. wick, but saves valuable time in troubleshooting. It allows you to be more accurate in removing SMD's.

**Randy Whitehead - Service West - Salt Lake City UT 801-262-4069**
My Techs thought it would be a waste. I bought one anyway after a demo. My Techs then fought over it. Now we have three. It is the Best desoldering tool we have ever used.

## Service Managers, Owners, CEO's, CFO's

*My personal guarantee to you is that after 90 days of ownership, if you are not convinced that you have made a wise decision for your business with the purchase of the SC-7000Z desoldering tools, your investment will be fully refunded with the return of the merchandise. Now you have no reason not to try it.*

*Jerry Howard, President.*

***Check us out on the WEB***
***http://www.heinc.com***
***Order from web site for 5% discount***

## New Specifications

- **Voltage**——AC100V,120V,230V,50/60Hz
- **Power Consumption**——120W
- **Pump**——Diaphragm Type
- **Motor Output**——12W
- **Vacuum Attained**——**650mmHg**
- **Temperature Range**——300°C—**500°C** (572°F—**932°F**)
- **Air Flow Rate**——15 Liter/Minute (Open)
- **Heater**——100W (Ceramic)
- **Control System**——Feed Back Zero Cross-over Type
- **Net Weight**——420Grams
- **Max.Temp. of Hot Blow**——400°C
- **The Most Cost Effective Desoldering Tool in the World.**

- Totally Self Contained diaphragm vacuum pump and AC motor for high vacuum suction or reversible hot air blow for SMD removal.
- 100Watt Ceramic heater with zero-crossover switching heater control circuit which prevents spikes and leakage currents.
- Unique patented long lasting filter cartridge design. Solder builds up on easily cleaned baffle, while air flows around the outside of baffle.
- Totally ESD Safe. The housing contains carbon and the tip is at

**Visa - M/C - Discover - American Express - Terms to Qualifying Companys**
**30 Day Money Back Total Satisfaction Guarantee - One Year Parts and Labor Warranty**

**HOWARD ELECTRONIC INSTRUMENTS INC**
*Your Desoldering Specialists*

**Toll Free U.S. and Canada**
**1-800-394-1984**

**Web Site www.heinc.com**
**E-Mail sales@heinc.com**
**International (316) 744-1993**
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CIRCLE 331 ON FREE INFORMATION CARD

# Use ELECTRONICS NOW Classifieds

## READ BY ELECTRONIC BUYERS AND SELLERS AND TRADERS

## INSTRUCTIONS FOR PLACING YOUR AD!

### HOW TO WRITE YOUR AD

**TYPE or PRINT** your classified ad copy CLEARLY (not in all capitals) using the form below. If you wish to place more than one ad, use a separate sheet for each additional one (a photo copy of this form will work as well). Place a category number in the space at the top of the order form (special categories are available). If you do not specify a category, we will place your ad under miscellaneous or whatever section we deem most appropriate.

We cannot bill for classified ads. **PAYMENT IN FULL MUST ACCOMPANY YOUR ORDER.** We do permit repeat ads or multiple ads in the same issue, but in all cases, full payment must accompany your order.

### WHAT WE DO

The first word and company name of each ad are set in bold caps at no extra charge. No special positioning, centering, dots, extra space, etc. can be accommodated.

### RATES

Our classified ad rate is $2.50 per word. Minimum charge is $37.50 per ad per insertion (15 words). Any words that you want set in bold are each .40 extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged anything additional. State abbreviations must be post office 2-letter abbreviations. A phone number is one word.

**If you use a Box number you must include your permanent address and phone number for our files. ADS SUBMITTED WITHOUT THIS INFORMATION WILL NOT BE ACCEPTED.**

For firms or individuals offering Commercial products or Services. **Minimum 15 Words.** 5% discount for same ad in 6 issues within one year; 10% discount for same ad in 12 issues.**Boldface (not available as all caps)**, add .40 per word additional. **Entire ad in boldface**, add 20%. **Tint screen behind entire ad**, add 25%. **Tint screen plus all boldface ad**, add 45%. **Expanded type ad**, add $4.00 per word.

**General Information:** A copy of your ad must be in our hands by the 13th of the fourth month preceding the date of issue ( i.e. Sept issue copy must be received by May 13th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding work day. Send for the classified brochure.

### DEADLINES

Ads not received by our closing date will run in the next issue. For example, ads received by November 13 will appear in the March issue that is on sale January 17. ELECTRONICS NOW is published monthly. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS, advertising credit only. No phone orders.

### CONTENT

**All classified advertising in ELECTRONICS NOW is limited to electronics items only. All ads are subject to the publishers' approval. WE RESERVE THE RIGHT TO REJECT OR EDIT ALL ADS.**

**AD RATES:** $2.50 per word, Minimum $37.50

Send you ad payments to:
**ELECTRONICS NOW 500 Bi-County Blvd, Farmingdale, NY 11735-3931**

## CATEGORIES

| | | | |
|---|---|---|---|
| 100 -- Antique Electronics | 270 -- Computer Equipment Wanted | 450 -- Ham Gear Wanted | 630 -- Repairs-Services |
| 130 -- Audio-Video Lasers | 300 -- Computer Hardware | 480 -- Miscellaneous Electronics For Sale | 660 -- Satellite Equipment |
| 160 -- Business Opportunities | 330 -- Computer Software | 510 -- Miscellaneous Electronics Wanted | 690 -- Security |
| 190 -- Cable TV | 360 -- Education | 540 -- Music & Accessories | 710 -- Telephone |
| 210 -- CB-Scanners | 390 -- FAX | 570 -- Plans-Kits-Schematics | 720 -- Test Equipment |
| 240 -- Components | 420 -- Ham Gear For Sale | 600 -- Publications | 730 -- Wanted |

## CLASSIFIED AD COPY ORDER FORM

**Place this ad in Category #**_________ **Special Category $30.00 Additional** ____________________

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 - $37.50 | 2 - $37.50 | 3 - $37.50 | 4 - $37.50 | 29 - $72.50 | 30 - $75.00 | 31 - $77.50 | 32 - $80.00 |
| 5 - $37.50 | 6 - $37.50 | 7 - $37.50 | 8 - $37.50 | 33 - $82.50 | 34 - $85.00 | 35 - $87.50 | 36 - $90.00 |
| 9 - $37.50 | 10 - $37.50 | 11 - $37.50 | 12 - $37.50 | 37 - $92.50 | 38 - $95.00 | 39 - $97.50 | 40- $100.00 |
| 13 - $37.50 | 14 - $37.50 | 15 - $37.50 | 16 - $40.00 | | | | |
| 17 - $42.50 | 18 - $45.00 | 19 - $ 47.50 | 20 - $50.00 | | | | |
| 21 - $52.50 | 22 - $55.00 | 23 - $57.50 | 24 - $60.00 | | | | |
| 25 - $ 62.50 | 26 - $65.00 | 27 - $67.50 | 28 - $70.00 | | | | |

Total words ________ $2.50 per word = $________

Bold Face ________ $0.40 per word = $________

Special Heading ________ $30.00 = $________

Other ________ = $________

**Total classified ad payment $**________ **enclosed** **TOTAL COST OF AD $**________

**[ ] Check** **[ ] Mastercard** **[ ] Visa** **[ ] Discover** Card # ____________________ Expiration Date __ __/__ __

Signature____________________

Name____________________ Phone____________________

Address____________________City State Zip ____________________

# CLASSIFIED

## MISCELLANEOUS ELECTRONICS FOR SALE

**PIECE parts for Delco OEM radios. Low pricing. Factory Original. No subs. Call today, 1 (800) 433-9657.**

**CHEAP** device programmers $59.95 & up. **XU-MICRO,** PO Box 14681 Houston, TX 77021. Add $5.00 S&H

## PLANS-KITS-SCHEMATICS

**BIO-Stimulator** featured in PE June issue. Tone muscles, relieve aches and pains with electronic acupuncture. Updated kit with enclosure $40.00 plus $2.50 S&H. **RAH PROJECTS,** PO Box 15904, N.B., California 92659

**ELECTRONIC PROJECT KITS.** 49 McMichael St. Kingston, ON., K7M 1M8. $3.00 catalog. www.qkits.com. **QUALITY KITS.**

## CABLE TV

**NEW!** Jerrold and Pioneer wireless test units $125.00 each, also 75DB notch filters $19.95 each, quantity pricing available. Please call **KEN ERNY ELECTRONICS,** 24 hour order and information hot line (516) 389-3536.

**CABLE descramblers and converters** 10 lot decoders $38.00 ea. 10 lot converters $57.00 ea. Visa and Mastercard accepted. (304) 337-8027.

**CABLE** TV Descramblers. One piece units. Pioneer, 6310's Scientific Atlanta 8580's Dpv 7's and others. Lowest prices. Money back guarantee. **Precision Electronics** Houston,TX. 1-888-691-4610

**Free Cable Descrambler Plans. For Details Write:** Sierra Publishing, 909 E. Yorba Linda Blvd., Suite H-181, Dept. ENQ, Placentia, CA 92870

**Signal Eliminator** can block severe TV interference or unwanted channels! Order by channel number - 0 thru 36 available. Only $30.00 each plus $4.00 S/H. Quantity discounts. Money back guarantee. Prepay, Visa or Mastercard. COD $5.00 additional. Visit us on the web today at http://startcircuits.com/tvfilter. **Star Circuits,** PO Box 94917, Las Vegas, NV 89193. 1-800-433-6319.

**CABLE TV** major brands including ZENITH ST. 1600 $249.00 New Zenith add-on $99.00 Jerrold Model CFT 2014 $299.00 add-on TVT $70.00 WHOLESALERS WELCOME **1-800-822-8530**

**Descramble** cable with simple circuit added to Radio Shack RF Modulator and using VCR tuner instructions $10.00 TELECOM, Box 832-E1, Brushly, LA 70719

**CABLE DESCRAMBLERS** and converters, shop no more, best prices and tech support. **Extreme Electronics** 1-888-609-4910

***NEW!*** Cellphone E.S.N. readers **$250** each, cell phone programmers **$175** each, cell phones **$25** each, DSS satellite dish card readers and programmers **$125** each, credit card readers **$250** each, Cable T.V. notch filters **50 cents** each, convertor boxes **$50** each, magnetic strip card readers for ATM machines, bank cards, drivers license, and all types of data acquisitions all under **$200** each. You pay these super low prices when you deal directly with the manufacturers. When you order "Direct Connection" a 150 page directory published by Ed Treki Publications, you will receive the largest collection of names, addresses, and phone numbers of all the leading American and International manufacturers of these products never before available. Stop paying second, third and fourth hand prices and deal directly with the source!!! Order your copy of "Direct Connection" today for **only $99.95 plus $5 shipping. All orders are sent C.O.D. Please call Ed Treki Publications 24 hour order hot line 914-544-2829.**

**CABLE BOXES - ALL MODELS - ALL CHANNELS** Jerrold Impulse DP, DPV & DPBB's, Pioneer or Scientific Atlanta-Lowest Prices in U.S. - $175.00 including remote, batteries and cable. Call for 10 lot pricing. Toll Free (888) 689-0779

**BIG SALE!! NOTCH FILTERS $18.00. EXTERNAL ACTIVATORS** and **DESCRAMBLERS FROM $99.00.** Test chips from $5.00. **BULLET/LD $10.00. NAME BRAND CABLE DESCRAMBLERS FROM $135.00. LET US BEAT YOUR BEST PRICE. 1-800-449-9189 ANYTIME. SE HABLE ESPANOLE**

**CABLE "Bullet Terminator and I.D. Blocker."** Electronically shields yourself and your box. Free Hackers Guide included. **Lifetime guarantee. Wholesale prices. 1-800-820-9024.**

**CABLE Descrambler!! Anyone can build** in **seven steps** with **Radio Shack** parts. **Plans/Kit** from **$5.00 plus Free Bonus!! 1-800-818-9103.**

**CABLE TV EQUIPMENT & ACCESSORIES.** Wholesalers Welcome! 30 Day Moneyback Guarantee! Free Catalog! **PROFORMANCE ELECTRONICS, INC. 1-800-815-1512**

**Cable** descramblers including **New T-2 Testers.** Fully activates Jerrold DP-5-CFT22xx's. **Multi-mode, Fiber optics.** Descrambles everything permanently, guaranteed. Lowest single or lot prices available. Se habla en espanol. Call **Cableking** (203) 849-1759, 24 hours a day. Website address www.ntplx.net/-cablkingabl.htm.

**Cable** test modules/cubes. Pioneers, S/A, Tocoms, Jerrolds, Quantity discounts. Call **DCR.** Tel: (718) 624-8334, Fax: (718) 246-9731. No NY calls.

**CABLE DESCRAMBLING, New secret manual.** Build your own Descramblers for Cable and Subscription TV. Instructions, schematics for SSAVI, Gated Sync, Sinewave, $12.95, $2 postage. **CABLETRONICS,** Box 30502R, Bethesda, MD 20824.

**CABLE TV DESCRAMBLERS. ALL MAJOR BRANDS HAVE MAKE AND MODEL NUMBER OF CONVERTER USED IN YOUR AREA WHEN CALLING. QUANTITY DISCOUNTS. K.D. VIDEO, 1-800-327-3407.**

## SATELLITE EQUIPMENT

**SKYVISION!** Your Satellite Home Entertainment Source. **Best values:** DBS and C/Ku-band equipment, including 4DTV. Most complete selection: Parts-Tools-Upgrades-Accessories! **Free** Discount Buyer's Guide. Call 800-543-3025. International 218-739-5231. www.skyvision.com.

**FREE DSS TEST CARD** information package. Works on new system and turns on all channels including PPV, adult and sport channels. Write **SIGNAL SOLUTIONS,** 2711 Buford Rd., Suite 180, Richmond VA 23235.

**DSS** Hacking: How to construct and program smart cards, w/pic 16C84, software. Complete DSS system schematics, $16.95. **CABLETRONICS,** Box 30502R, Bethesda, MD 20824.

**VIDEOCYHER II** descrambling manual. Schematics, video and audio. Explains DES, EPROM, CloneMaster, Pay-per-view $16.95, $2.00 postage. Schematics for Videocypher II Plus, $20.00. Schematics for Videocypher II 032, $15.00. Software to copy and alter EPROM codes, $25.00. VCII Plus EPROM, binary and source code, $30.00. **CABLETRONICS,** Box 30502R, Bethesda, MD 20824.

## TEST EQUIPMENT

**TEST Equipment** pre-owned now at affordable prices. Signal generators from $50.00, oscilloscopes from $50.00. Other equipment including manuals available. Send $2.00 US for catalog. **Refunded** on first order. **J.B. Electronics,** 3446 Dempster, Skokie, IL 60076. (847) 982-1973.

**TEST EQUIPMENT SALE! VIEW COMPLETE LIST AT WEB SITE** "a-mall.com" or call **NOW** to recieve list by fax or mail. **AST GLOBAL ELECTRONICS:** Voice 888-216-7159; Fax: 814-398-1176; e-mail:astmrktg@wrench.toolcity.net

## BUSINESS OPPORTUNITIES

**ELECTRONICS BUSINESSES,** Home based. Part/Full time. 250pg Comprehensive Guidebook, insider information. $19.95 24hr recording **(800) 326-4560** x 159

**EASY WORK!** EXCELLENT PAY! Assemble Products At Home. Call Toll Free 1-800-467-5566 EXT. 5192

## EDUCATION & INSTRUCTION

**LEARN** Electronics. Home study. Outstanding careers. Free literature. **P.C.D.I.,** Atlanta, Georgia. 1 (800) 362-7070 Dept. ELF342.

## CB-SCANNERS

**CB Radio Modifications!** Frequencies, kits, high-performance accessories, books, plans, repairs, amps, 10-Meter conversions. The best since 1976! Catalog $3.00. **CBCI**, Box 31500EN, Phoenix, AZ 85046.

## COMPONENTS

**SAVE $$$** Reclaimed electro-mech/electronic components and assemblies. SASE for list. 800/334-1159, **PMA Services,** 22347 La Palma Ave. #106, Yorba Linda, CA 92887

## MISC. ELECTRONICS WANTED

**TUBES:** "oldest". "latest". Parts and schematics. SASE for lists. **Steinmetz Electronics,** 7519 Maplewood Ave., Hammond, Indiana 46324.

## WANTED

**WANTED: USED TEST EQUIPMENT. TURN IDLE OR UNWANTED EQUIPMENT INTO CASH. AST GLOBAL ELCTRONICS:** Voice 888-216-7159; Fax: 814-398-1176; e-mail:astmrktg@wrench.toolcity.net

## SCRAMBLING NEWS

**Best satellite** TV news includes coverage of piracy. Voice/Fax 716-283-6910. www.scramblingnews.com.

## BEST BY MAIL

Rates: Write National, Box 5, Sarasota, FL 34230

**HIGH SCHOOL DIPLOMA** Fast, Accredited, Member Christian Schools International. 1-800-470-4723.

**CASH NOW FOR FUTURE PAYMENTS!** We buy payments from Insurance Settlements, Annuities, and Class Action Awards. We also buy Owner Financed Mortgage Notes. Call R&P Capital at 1-800-338-5815, Ext. 500.

**TOP $$$$s FOR** TD's, Contracts, Mortgage Notes: 1-888-544-4089.

**ELIMINATE HOUSEHOLD PESTS** using the Ultrasonic Pestrepeller. Money-back guarantee. 1-888-430-7576 Ext. 3120.

## ADVERTISING INDEX

Electronics Now does not assume any responsibility for errors that may appear in the index below.



## ADVERTISING SALES OFFICES


**Gernsback Publications, Inc.**
**500 Bi-County Blvd.**
**Farmingdale, NY 11735-3931**
**1-(516) 293-3000**
**Fax 1-(516) 293-3115**

**Larry Steckler**
publisher (ext. 201)
e-mail advertising@gernsback.com

**Adria Coren**
vice-president (ext. 208)

**Ken Coren**
vice-president (ext. 267)

**Christina Estrada**
assistant to the publisher (ext. 209)

**Arline Fishman**
advertising director (ext. 206)

**Marie Falcon**
advertising assistant (ext. 211)

**Adria Coren**
credit manager (ext. 208)

**For Advertising ONLY**

**EAST/SOUTHEAST**
**Stanley Levitan**
Eastern Advertising
1 Overlook Ave.
Great Neck, NY 11021-3750
1-516-487-9357
Fax 1-516-487-8402
slevitan26@aol.com

**MIDWEST/Texas/Arkansas/Okla.**
**Ralph Bergen**
Midwest Advertising
One Northfield Plaza, Suite 300
Northfield, IL 60093-1214
1-847-559-0555
Fax 1-847-559-0562
bergenrj@aol.com

**PACIFIC COAST**
**Janice Woods**
Pacific Advertising
Hutch Looney & Associates, Inc.
6310 San Vicente Blvd., Suite 360
Los Angeles, CA 90048-5426
1-213-931-3444 (ext. 228)
Fax 1-213-931-7309
woodyowl@aol.com

**Electronic Shopper**
**Joe Shere**
National Representative
P.O. Box 169
Idyllwild, CA 92549-0169
1-909-659-9743
Fax 1-909-659-2469
Jshere@gernsback.com

**Megan Mitchell**
National Representative
9072 Lawton Pine Avenue
Las Vegas, NV 89129
Phone/Fax 702-838-6924
Lorri88@aol.com

**Customer Service**
1-800-999-7139
7:00 AM - 6:00 PM M-F MST

# Reader Service Card

## MAIL-FAX OR E-MAIL YOUR REQUEST

## Now you have 3 ways to request free information on products and services featured in this issue

**To insure a prompt reply, please furnish all requested information**

### To Receive Information on Products and Services in This Issue

Circle the numbers corresponding to the advertised products or editorial items that interest you.
Mail Card
or Fax To: (413) 637-4343
or E-Mail your request to:
BERKCOMP@AOL.COM.

### For E-Mail users, your subject is Electronics Now 5/98

### Format your message:

- Name and Address information
- Telephone and Fax numbers
- Requested item numbers separated by commas
- Responses to survey questions separated by dashes or slashes

NOTE: Submit all Free Information requests by **EITHER** Fax, mail, or E-Mail **DUPLICATE REQUESTS WILL BE DISCARDED**. Use for Free Information only. Address all editorial inquiries to Editor, Electronics Now, 500 Bi-County Blvd., Farmingdale, NY 11735-3931

**BUSINESS PROFESSIONAL FREE INFORMATION CARD**

Electronics NOW®

4DAE6

Name ______________________ Title ____________

Company ______________________

Dept. MS ______________________

Daytime Business Phone ______________________

Company Address ______________________

City ____________ State ________ Zip +4 ________

Unclear or incomplete mailing info will prevent our processing this request.

2 ☐ Please send me 12 issues (1 year) of ELECTRONICS NOW for $19.97 and bill me. (Canada $27.79 — US Funds only — Includes G.S.T.)

4 ☐ Please send me 12 issues (1 year) of POPULAR ELECTRONICS for $18.95 and bill me. (Canada $25.63 — US Funds only — Includes G.S.T.)

Do you service electronic equipment? 5 ☐ Yes 6 ☐ No

What kind of electronic equipment do you service?
7 ☐ Consumer Electronics 8 ☐ Computers
9 ☐ Communications 10 ☐ Industrial Electronics

VOID after July 31, 1998

**Allow 6-8 weeks for delivery of first issue**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 31 | 60 | 89 | 118 | 147 | 176 | 205 | 234 | 263 | 292 | 321 | 350 |
| | 32 | 61 | 90 | 119 | 148 | 177 | 206 | 235 | 264 | 293 | 322 | 351 |
| | 33 | 62 | 91 | 120 | 149 | 178 | 207 | 236 | 265 | 294 | 323 | 352 |
| | 34 | 63 | 92 | 121 | 150 | 179 | 208 | 237 | 266 | 295 | 324 | 353 |
| | 35 | 64 | 93 | 122 | 151 | 180 | 209 | 238 | 267 | 296 | 325 | 354 |
| | 36 | 65 | 94 | 123 | 152 | 181 | 210 | 239 | 268 | 297 | 326 | 355 |
| | 37 | 66 | 95 | 124 | 153 | 182 | 211 | 240 | 269 | 298 | 327 | 356 |
| | 38 | 67 | 96 | 125 | 154 | 183 | 212 | 241 | 270 | 299 | 328 | 357 |
| | 39 | 68 | 97 | 126 | 155 | 184 | 213 | 242 | 271 | 300 | 329 | 358 |
| | 40 | 69 | 98 | 127 | 156 | 185 | 214 | 243 | 272 | 301 | 330 | 359 |
| | 41 | 70 | 99 | 128 | 157 | 186 | 215 | 244 | 273 | 302 | 331 | 360 |
| | 42 | 71 | 100 | 129 | 158 | 187 | 216 | 245 | 274 | 303 | 332 | 361 |
| 14 | 43 | 72 | 101 | 130 | 159 | 188 | 217 | 246 | 275 | 304 | 333 | 362 |
| 15 | 44 | 73 | 102 | 131 | 160 | 189 | 218 | 247 | 276 | 305 | 334 | 363 |
| 16 | 45 | 74 | 103 | 132 | 161 | 190 | 219 | 248 | 277 | 306 | 335 | 364 |
| 17 | 46 | 75 | 104 | 133 | 162 | 191 | 220 | 249 | 278 | 307 | 336 | 365 |
| 18 | 47 | 76 | 105 | 134 | 163 | 192 | 221 | 250 | 279 | 308 | 337 | 366 |
| 19 | 48 | 77 | 106 | 135 | 164 | 193 | 222 | 251 | 280 | 309 | 338 | 367 |
| 20 | 49 | 78 | 107 | 136 | 165 | 194 | 223 | 252 | 281 | 310 | 339 | 368 |
| 21 | 50 | 79 | 108 | 137 | 166 | 195 | 224 | 253 | 282 | 311 | 340 | 369 |
| 22 | 51 | 80 | 109 | 138 | 167 | 196 | 225 | 254 | 283 | 312 | 341 | 370 |
| 23 | 52 | 81 | 110 | 139 | 168 | 197 | 226 | 255 | 284 | 313 | 342 | 371 |
| 24 | 53 | 82 | 111 | 140 | 169 | 198 | 227 | 256 | 285 | 314 | 343 | 372 |
| 25 | 54 | 83 | 112 | 141 | 170 | 199 | 228 | 257 | 286 | 315 | 344 | 373 |
| 26 | 55 | 84 | 113 | 142 | 171 | 200 | 229 | 258 | 287 | 316 | 345 | 374 |
| 27 | 56 | 85 | 114 | 143 | 172 | 201 | 230 | 259 | 288 | 317 | 346 | 375 |
| 28 | 57 | 86 | 115 | 144 | 173 | 202 | 231 | 260 | 289 | 318 | 347 | 376 |
| 29 | 58 | 87 | 116 | 145 | 174 | 203 | 232 | 261 | 290 | 319 | 348 | 377 |
| 30 | 59 | 88 | 117 | 146 | 175 | 204 | 233 | 262 | 291 | 320 | 349 | 378 |


**BUSINESS PROFESSIONAL FREE INFORMATION CARD**

Electronics NOW®

4DAE6

Name ______________________ Title ____________

Company ______________________

Dept. MS ______________________

Daytime Business Phone ______________________

Company Address ______________________

City ____________ State ________ Zip +4 ________

Unclear or incomplete mailing info will prevent our processing this request.

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| | 33 | 62 | 91 | 120 | 149 | 178 | 207 | 236 | 265 | 294 | 323 | 352 |
| | 34 | 63 | 92 | 121 | 150 | 179 | 208 | 237 | 266 | 295 | 324 | 353 |
| | 35 | 64 | 93 | 122 | 151 | 180 | 209 | 238 | 267 | 296 | 325 | 354 |
| | 36 | 65 | 94 | 123 | 152 | 181 | 210 | 239 | 268 | 297 | 326 | 355 |
| | 37 | 66 | 95 | 124 | 153 | 182 | 211 | 240 | 269 | 298 | 327 | 356 |
| | 38 | 67 | 96 | 125 | 154 | 183 | 212 | 241 | 270 | 299 | 328 | 357 |
| | 39 | 68 | 97 | 126 | 155 | 184 | 213 | 242 | 271 | 300 | 329 | 358 |
| | 40 | 69 | 98 | 127 | 156 | 185 | 214 | 243 | 272 | 301 | 330 | 359 |
| | 41 | 70 | 99 | 128 | 157 | 186 | 215 | 244 | 273 | 302 | 331 | 360 |
| | 42 | 71 | 100 | 129 | 158 | 187 | 216 | 245 | 274 | 303 | 332 | 361 |
| 14 | 43 | 72 | 101 | 130 | 159 | 188 | 217 | 246 | 275 | 304 | 333 | 362 |
| 15 | 44 | 73 | 102 | 131 | 160 | 189 | 218 | 247 | 276 | 305 | 334 | 363 |
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| 17 | 46 | 75 | 104 | 133 | 162 | 191 | 220 | 249 | 278 | 307 | 336 | 365 |
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| 21 | 50 | 79 | 108 | 137 | 166 | 195 | 224 | 253 | 282 | 311 | 340 | 369 |
| 22 | 51 | 80 | 109 | 138 | 167 | 196 | 225 | 254 | 283 | 312 | 341 | 370 |
| 23 | 52 | 81 | 110 | 139 | 168 | 197 | 226 | 255 | 284 | 313 | 342 | 371 |
| 24 | 53 | 82 | 111 | 140 | 169 | 198 | 227 | 256 | 285 | 314 | 343 | 372 |
| 25 | 54 | 83 | 112 | 141 | 170 | 199 | 228 | 257 | 286 | 315 | 344 | 373 |
| 26 | 55 | 84 | 113 | 142 | 171 | 200 | 229 | 258 | 287 | 316 | 345 | 374 |
| 27 | 56 | 85 | 114 | 143 | 172 | 201 | 230 | 259 | 288 | 317 | 346 | 375 |
| 28 | 57 | 86 | 115 | 144 | 173 | 202 | 231 | 260 | 289 | 318 | 347 | 376 |
| 29 | 58 | 87 | 116 | 145 | 174 | 203 | 232 | 261 | 290 | 319 | 348 | 377 |
| 30 | 59 | 88 | 117 | 146 | 175 | 204 | 233 | 262 | 291 | 320 | 349 | 378 |

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